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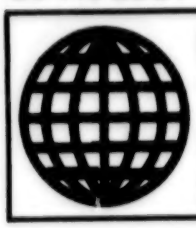

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Germany: Brazecoat Technology Improves Wear, Corrosion Resistance in Materials

94WS0485A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 4 Aug 94 p 8

[Unsigned article; "Brazecoat Protects Against Wear and Tear"]

[Text] The Frankfurt enterprise Degussa AG has succeeded in producing a pulverized hard material using nickel-based solders or copper-based solders adhering to the surface of a base metal (such as steel). With this so-called Brazecoat method an effectively sealing and corrosion-resistant hard bonding layer is applied to the base metal which bonds inseparably with it. The Brazecoat technology is so multipurpose, according to Degussa publicity, that even bent surfaces constitute no problem. The combination is affording great advantages, especially in the chemical engineering and processing industry. The present-day range of corrosion-protection techniques extends from chemical and electrochemical methods through physical methods to thermal sprays, as well as plating and built-up welding methods.

Germany: Diamond Film Deposition on Silicon Studied

94P60340A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 4 Aug 94 p 8

[Article entitled: "Diamond Film Deposition on Silicon: Augsburg Researchers Successful in Heterotactic Deposition"]

[Text] The capability to deposit single crystal films on an inexpensive substrate, for example, silicon, one of the most important materials in electronics, is an important requirement for the use of diamond in electronics. The University of Augsburg (Chair for Experimental Physics IV, Memminger Str. 6, 86135 Augsburg) has had initial success in this area.

Single crystal deposition is still a thing of the future, say researchers, but heterotactic deposition of diamond on silicon has already been proved at Augsburg. [This deposition] concerns a film which exhibits a fixed relationship to the silicon base. Although the film is not single crystalline, it clearly has better electronic properties than the usual polycrystalline films.

The diamond films are produced using a carbon-containing gas mixture, which is converted to a plasma by microwaves. The carbon vapor then condenses as a diamond film on the cooler silicon substrate. This low-pressure technique is also referred to as plasma-CVD (chemical vapor deposition).

Diamond has a number of properties for use in electronic components. It is better than all other materials, including silicon, with respect to heat conductivity, electrical insulation, and charge carrier mobility.

Diamond can be doped and then has semiconducting properties. Another advantage is its high temperature resistance. While a conventional silicon diode is destroyed at a temperature of 100°C, diamond diodes operate even above 500°C. The ability to tolerate high temperatures also permits considerably higher performance in electronics.

Nevertheless, it will be some time until a high-performance diamond chip is available, say the Augsburg scientists. The deposition technology has been well developed and scientists are working intensively on production of single crystal diamond films, but doping with impurity atoms, through which the film acquires semiconducting properties, remains difficult as before. There are already p-type semiconducting diamonds. A suitable method of producing n-type semiconducting diamonds must still be found.

AEROSPACE

ESA Studies In-Orbit Satellite Service Vehicle

94WS0473A Noordwijk ESA BULLETIN in English May 94 pp 33-39

[Article by W. De Peuter, G. Visentin, W. Fehse and A. Elfving, ESA Technical Directorate, ESTEC, Noordwijk, The Netherlands; D.L. Brown and E. Ashford, ESA Telecommunications Directorate, ESTEC, Noordwijk, The Netherlands: "Satellite Servicing in GEO by Robotic Service Vehicle"; first paragraph boxed item and in bold print]

[Text] **The geostationary orbit has a high commercial and strategic value, as do the satellite systems stationed there, for telecommunication, TV broadcasting, and weather forecasting. To safeguard the huge capital investments made as well as the usability of the orbit itself, it will soon be necessary to have adequate means of remote intervention for the servicing and repair of satellites. Since the physical, technical and economic constraints of such a mission make servicing by astronauts impossible, robotic service vehicles will have to do the work. ESA is now studying a robot-based Geostationary Service Vehicle, which would be similar to deep-sea and nuclear servicing robots.**

Introduction

ESA is presently investigating the characteristics and potential of a Geostationary Service Vehicle (GSV) which could provide in-orbit inspection of geostationary satellites and intervention when necessary. So far, three types of services or "interventions" have been identified:

—inspection of a satellite that has a severe malfunction and where a close-up view of the satellite could help to clarify the problem. This diagnostic data can be a basis for recovery actions from ground.

—mechanical assistance to a satellite in trouble, for example, with a non-deployed solar array or antenna, to restore operation.

—end-of-life re-orbiting of uncontrolled satellites into a graveyard orbit, an operation that will become more and more important in order to maintain the commercial exploitation potential of the geostationary orbit (GEO).

As was demonstrated recently with the successful repair of the Hubble Space Telescope, very good servicing results can be obtained if the subject satellite is built with the intention of being serviced later. However, because of the existing fleet of conventional satellites, a GSV must also be able to perform meaninful intervention tasks on commercial spacecraft that are not designed for in-orbit servicing.

GSV system overview

Concept feasibility

The baseline thinking is that a GSV should "pay for itself," at least once it is in orbit. However, its capabilities and services must be sufficiently comprehensive to be attractive to satellite operators. This means that in order to be commercially viable both the development and operational costs must be kept within very tight bounds. Many of the enabling technologies for a GSV exist but still need to be adapted for use in space and to be proven in flight. A number of technological challenges also still need to be resolved, including the rendezvous, circumnavigation and approach to a non-cooperative spacecraft followed by its robotic capture and berthing.

Typical target spacecraft are spinning or three-axis stabilised telecommunication satellites positioned (or drifting) along the GEO arc. Examples of satellites with real problems for which a GSV could have been very useful are given in Table 1.

Table 1. Examples of satellites for which GSV services could have been very useful

Satellite	Problem	GSV action
Olympus	Satellite in unknown configuration and not controllable	Close-up inspection
Anik-E2	Only partial deployment of C-band reflector	Close-up inspection/ mechanical intervention
TV Sat1	Non-deployment of solar panel	Mechanical intervention
Marecs-A	Solar array drive stuck	Mechanical intervention

Commercial potential

From an economic point of view, mechanical interventions are the type of GSV intervention with the greatest revenue potential. However, since spacecraft failures are unpredictable, it is difficult to base a commercial plan on the intervention missions alone. Re-orbiting missions, on the other hand, could provide a more steady income. If it was planned to move the spacecraft when depleted from its operational slot into a graveyard orbit using a GSV, a telecom satellite could continue operating until propellant depletion (roughly six months of extra exploitation). Additional revenues would be generated, and a reasonable share of this extra profit could be claimed by the GSV operator. Another potential GSV service is to re-orbit "dead" satellites which could otherwise be a collision hazard to other satellites. For inspection tasks, revenues are expected to be low, although they could become considerable if the inspection leads to the recovery of the satellite.

It is estimated that a GSV could become economically viable if the design costs of the GSV can be kept in the range of two to three times the launch cost. This could be achieved by maturing the required technology via separate technology programmes to reduce the design risk. Here, ESA could play a key role in mobilising the available European expertise to provide a technical and commercial basis for a GSV.

Basic GSV configuration

The proposed configuration for a GSV (Fig. 1) [not shown], synthesised during ESA's recent industrial study, is a satellite that would use the maximum upload capability of a dedicated Ariane-4 launch, thus a 4.2 ton spacecraft at launch. With a dry mass of approximately 1.2 tons, roughly 3 tons remain for fuel, which means a total delta-v of 3687 m/s (for a bi-propellant with a specific impulse of 300 seconds). The hexagonal configuration proposed uses the full fairing diameter of the launcher, and the height of the spacecraft is sized in proportion to the three tons of fuel. Solar panels would unfold from the outer surface of the hexagon, and the rendezvous sensors, the robot arm and its tools would be located on the top surface of the GSV. The bottom surface would be dedicated to the launcher interface ring and the GSV propulsion system.

GSV operation

It is proposed to operate the GSV through a dedicated, portable ground station. The S-band would be used for communication and the dedicated station would be co-located with the customer's main ground station. A key driver in the design of the antenna arrangement on board the GSV, will be the continuity of the communication link during all proximity operations. Low gain S-band antennas with wide lobes are proposed, especially for approach operations when the target spacecraft may obstruct the GSV antenna visibility.

GSV orbital manoeuvring

Fuel consumption and GSV lifetime

The primary requirement for a commercial GSV is its capability to reach as many target spacecraft as possible during its operational life. Once launched and positioned at its "home" location, the GSV's ability to reach a troubled satellite is directly related to the amount of fuel the GSV operator is prepared to expend. The main fuel consumption parameters are the speed at which the GSV moves along the orbit, the phasing and inclination differences for which correction is needed, and the number of re-orbiting operations. Based on a scenario consisting of 25 re-orbiting missions, 10 inspections, 3 mechanical interventions, and 2 dead satellite removals, the proposed GSV configuration would have an operational lifetime of five years.

Rendezvous

The basic phases of a rendezvous are illustrated in Figure 2 [not shown]. After a call for assistance, the GSV begins the transfer to the troubled satellite by moving from its home position toward the target spacecraft, with a drift orbit a few hundred kilometres below the geostationary orbit. When it arrives within 10 km of the target spacecraft, the GSV is transferred back to the geostationary orbit (points S1 to S2). The GSV then approaches the target carefully (S2 to S4) and circumflies it to obtain status information (S4 to S5). The GSV then makes its final approach in preparation for capturing the target.

The rendezvous is performed with the help of ground tracking, radar tracking or angular measurement with a star-tracker, and eventually TV- camera tracking.

Final approach

When the GSV is within 50 metres of the target spacecraft, it begins its final approach and using its robotic arm, captures the target (S6 to S7). The target is docked to the GSV itself and later they are "rigidised" so that both spacecraft form one rigid compound. The robotic servicing intervention can then begin.

The GSV approaches a controlled satellite stabilised in its nominal Earth-pointing position from behind, along the Earth direction. In the case of an uncontrolled satellite, the target is expected to spin slowly around its main axis of inertia; for most satellites, this axis is perpendicular to the solar-array plane. The GSV then makes its final approach along the spin axis of the target satellite. At the very last moment, the GSV (or possibly its robotic capture tool) will be spun up to synchronise with the target.

For both controlled and uncontrolled satellites, it seems realistic to assume that the GSV can maintain a relative position and attitude accuracy of +/-5 cm and +/-2 degrees with respect to the target. This does not apply for the roll axis of a spin-stabilised target since the roll-motion synchronisation will be done by a rotating capture tool. Possible nutations around the spin axis could be compensated by the robot holding the capture tool. After capture, the GSV will slow down the rotation of the target until both spacecraft attain the same rate. The "rigidisation" between the two can then take place, the single point attachment between the two spacecraft is replaced by a more stable, multi-point fixation structure to strengthen and stiffen the bond between the GSV and the target satellite and to free the robot arm for other uses.

GSV robotic system

Why robots?

A GSV will be uncrewed, and the broad variety of tasks to be done, in combination with the unpredictable nature of the servicing tasks, calls for a flexible and multi-functional flight segment. Robotic systems are the only means available today to fulfil these needs. In addition, a robot can be controlled in a telemanipulation mode by a remote ground operator. In the case of a GEO-stationed spacecraft, the direct telecommunication link enables a good band-width. Because of the short time delay between ground control and the flight segment, the GSV robot can be operated in a telemanipulation mode of very good quality. This means that the motion of a ground master arm manipulated by a skilled operator, can be "slaved" by the GSV robot and, in that way, quasi-human repair capabilities can be obtained.

As far as the robotic interaction with a conventional satellite is concerned, two major problems appear: 1) the limited options for capture/berthing and docking, and 2) the accessibility of the repair area for the GSV robotic system.

Robotic capture, berthing and docking

The robot arm must capture the target satellite, berth it to the GSV to align the axes of the two spacecraft, and dock it firmly. On a satellite that is fully covered with thermal insulation, there are few possibilities for proper mechanical interfacing with the GSV. However, two "hard points" that are available on virtually all GEO satellites are the nozzle of the apogee boost motor and the launcher interface ring. The nozzle may not provide sufficient stiffness for use as the final docking interface but could serve as a first "hook" for capture and temporary attachment. Rigidisation between the GSV and the launcher interface ring can then be performed. Due to a lack of standardisation in nozzles and interface rings, the capture and rigidisation mechanisms of the GSV must be highly adaptive.

An example of a nominal GSV manoeuvre with a stabilised target is illustrated in Figure 3 [not shown]. The GSV will service the Anik-E2 satellite, whose C-band reflector had only partially deployed. The GSV robot first prepares the spacecraft by erecting the docking/rigidisation structure (Fig. 3a) [not shown]. The GSV then approaches Anik-E2 from behind (Fig. 3b) [not shown] and captures it by its main engine nozzle (Fig. 3c) [not shown]. The robot will do this using a dedicated capture tool. In the case of a spinning spacecraft, the GSV will be spun up to the same speed along the same axis. The capture tool's "stinger" is inserted via the nozzle in the combustion chamber and expanded to prevent the target from escaping. Then the capture tool clamps to the outer ring of the nozzle to achieve a greater stiffness. The robot arm berths the spacecraft to the GSV (Fig. 3d) [not shown] by latching the other end of the capture tool into its fixed position. The robot arm is now released and picks up a gripper from its toolbox (Fig. 3e) [not shown]. The robot then performs the intervention: it reaches for the stuck antenna, releases it and deploys it into its operational position (Fig. 3f)[not shown].

In the case of an uncontrolled tumbling target (Fig. 4) [not shown], the capture tool will be spun up in synchronisation with the rotation of the nozzle. The robot arm also compensates for part of the orbital motion by keeping the capture tool aligned with the nozzle. It is expected that the images provided by the rendezvous camera on the main body of the GSV will give sufficiently accurate information so that the robot arm can safely insert the stinger of the capture tool in the combustion chamber. During insertion, the robot will continuously adjust its motion based upon distance and

contact force measurements. After latching, the robot arm and the capture tool will gradually eliminate the tumbling motions, and the berthing and docking of the two spacecraft will then follow.

Robotic mechanical intervention

The intervention for servicing can be divided into three sub-phases:

—reaching the repair zone
—close inspection of the repair zone
—intervention using tools, e.g., removing and replacing sections of the thermal blanket severing restraint cables that prevent deployment of the antenna or solar array, or hinging/removing deployable mechanisms that are stuck.

A major disadvantage of the capture and docking concept described, is the distance (roughly 5 metres) between the repair area and the GSV. Indeed, most of the defects are expected to be at the other extreme of the satellite where the payloads and subsystems, such as antenna reflectors, are located. It will require innovative robotic systems that can easily access the servicing area and at the same time provide good local precision, dexterity and stiffness to enable a good repair.

Robotic concepts

An obvious solution is to have one or two large robot arms that operate from the top face of the GSV and which can access the service zone directly. This straightforward solution can adequately solve the accessibility problem but a severe limitation is that these big crane-type robots have limited manipulation capabilities. First, the precision is in the order of centimetres or even decimetres which is often insufficient for repair work. Secondly, the local dexterity, i.e., the freedom of motion available at the robot tip, in this stretched position, is generally quite poor. This necessitates a very specific tool set to compensate for these limitations, implying less universality and thus less possibilities to cope with unforeseen defects.

Another candidate concept is a micro-macro manipulator. This is a cascade configuration of a large manipulator carrying a small, instrumental robot. Technically, this is a very attractive solution since both robots complement each other well. The large one acts like a cherrypicker-crane that carries a small, dextrous robot (often with two arms) to the repair zone to do the precise part of the work. This concept is popular on ground and in LEO [Low Earth Orbit], but the equipment tends to be heavy and the concept is therefore less effective in GEO where every kilogram counts. It is also a more expensive solution which jeopardises the potential commercial future of a GSV.

At the research level, new robotic concepts are being developed which could be very useful for later versions of a GSV. For instance, there are already testbeds of a small robot which is able to build a lightweight structure (e.g., a truss) on its own, and over which it can move easily. Such a scaffold could provide a universal structure used to bring a small instrumental robot to where it is needed.

Robotic tool set

In the same way as a human worker needs a comprehensive tool set for repair tasks, a GSV robot cannot perform all the tasks mentioned with one universal end-effector. A number of tools that are required were identified in the industrial study:

—a satellite-capture tool
—a docking/rigidisation tool
—a satellite close-up inspection tool
—a two-finger gripper
—a cable/pin cutter
—a self-reacted lever-force tool.

Some tools, such as inspection cameras, can be permanently mounted on the robot arm. Others must be detachable end-effectors, preferably designed as a modular family to minimise mass and volume.

Control concept

The GSV proximity and robotic operations normally require complex control systems. However, due to the availability of a continuous and direct communication link, the general control concept for a GSV is to have only the bare minimum of control functions implemented on board. For rendezvous, these necessary on-board functions are to ensure attitude and position stability, and back-up procedures to ensure the integrity and health of both the GSV and target satellite, in case ground control is lost. For robotics, the control functions on board are to ensure robot arm motion stability and accuracy, and to perform guidance for time critical motions such as the capture of a target satellite.

Spin-off potential

The similiarity between robotic servicing in GEO and deep-sea exploration and exploitation and nuclear-reactor servicing is striking. Remote intervention in hostile environments is expected to become increasingly important in the future, with new applications such as in the clean-up of radioactive or toxic waste, firefighting, de-mining, the handling of explosives or inflammable materials, security and police work, telemedicine, and in many other areas. A technology programme for the development of a GSV could act as a precursor to robotic servicing in the other environments, offering promising potential spin-off benefits to those terrestrial applications.

Acknowledgement

The authors would like to acknowledge DASA [German Aerospace Company] in Bremen and Ottobrunn (Germany) and its subcontractors, SPAR in Toronto (Canada), GMV in Madrid (Spain) and ESYS in Guildford (UK), which have studied Geostationary Service Vehicle concepts under ESA contract.

ESA Four-Stage Plan for Moon Exploration

MI1108090394 Rome AIR PRESS in Italian 4 Jul 94 p 1321

[Text] This year marks the 25th anniversary of man's landing on the Moon (Apollo 11, 21 July 1969), and now it

is the right time to start the first stage of an international lunar program, to prepare the future decisions for the subsequent stages, to start the necessary cooperation and coordination among the various agencies, and to establish a mechanism for the regular coordination of these activities at an operative level. There was universal agreement on these four points at the "Lunar Workshop" which was organized by the European Space Agency [ESA] at the invitation of the Swiss government. The workshop recently closed at Beatenberg, deciding that another meeting should be held in the middle of 1996, when—the participants are certain—there will be concrete projects to be examined for this plan that could be realized in the coming 15-20 years, and progress will have been made in the various aspects of international cooperation that they intend to promote in the town near Bern.

The final report estimates that the first stage of the program, which will last five years, will require an economic commitment of 600 billion lire. The same document states that each of the principal space agencies (NASA, ESA, RKA [Russian Space Agency], and NASDA [Japan's National Space Development Agency]) possesses "the technical and financial capacity to autonomously prepare the program for the first stage, but that a coordinated action would assure greater scientific and technological benefits for everyone. It should be remembered that in Japan large industries are urging their government to start a national program for the colonization of the Moon.

The experts from the large agencies mentioned and from the national agencies starting with the French CNES [National Center for Space Studies], agree that the single Earth-Moon system offers a variety of "rich opportunities." The potential of the Moon as a natural "long-term space station" for activities to be carried out directly on location (astronomical studies, scientific and industrial studies in microgravity, extraction of materials, etc.) and as an intermediate base for further strides forward in the exploration of space, starting with missions to Mars, has been recognized. However, as Roger Bonnet, scientific director of the ESA said, the Moon is "the closest alien location to the Earth where man could experiment on the necessary know-how to conquer the other planets of the solar system, and the ESA should take this into account when formulating the proposals for its long-term plan that is to be submitted to the European research ministers at their next meeting in 1995. If the Beatenberg program is approved at that meeting, the first European lunar probe could be launched in 2003."

Perhaps it was precisely in view of this schedule that Jacques Dordain, assistant director responsible for strategy and international policy, spoke on behalf of the ESA at Beatenberg sketching out how the plan could be divided into four stages, and airing the idea that the first two could be realized in a purely or mainly European context. Bonnet recalled that, among other things, Europe could offer both the launcher (Ariane 5) and the special instruments for preliminary exploration, the satellite MORO [Moon Robotic Orbiter], which has been studied in particular by Italian scientists, to prepare a map 10 times more precise than that recently constructed by the American probe Clementine and the Leda robot vehicle for ground analyses in areas that are still little known, such as those near to the poles.

The first stage should start toward the end of the century and its characteristics should be exclusively those of exploration and the development of the materials needed for the successive stage. This would be the initial stage of a "permanent robotic presence," executed by new high-performance automatic equipment, including a gigantic radio telescope. At this point lunar activity will have stimulated significant progress in robotics and the remote control sciences that, moreover, will also have important applications on Earth. The third stage, that should start before 2010, plans for a series of missions to set up a large astronomical base and one that will serve a future plant for the extraction of materials and/or oxygen from lunar rocks. This activity, which constitutes the fourth stage, could start less than ten years later, and could be that of the continuous presence of man on the Moon if this results opportune from the experience of the preceding stages.

ESA Sponsors Development of Electric Propulsion for Satellites

94WS0486A Noordwijk PREPARING FOR THE FUTURE in English Jun 94 pp 4-5

[Article: "Development of Satellite Electrical Propulsion Systems": G. Saccoccia, Propulsion and Aerothermodynamics Division, ESTEC; W. Deininger, BPD Difesa e Spazio; F. Paganucci & F. Scortecci, Centrospazio]

[Text]

Contractors:

BPD Difesa e Spazio
Centrospazio

Funding:

Advanced Supporting Technology Programme Phase 3 (ASTP-3)

Introduction

Electric propulsion results from accelerating a propellant either by electrical heating or by applying electrical and magnetic forces.

It has gained world-wide acceptance as for use in spacecraft, due to its suitability for very precise pointing and positioning applications and the large mass savings which can be achieved compared to conventional satellite propulsion systems. Electric propulsion systems are reliable. Arcjet thrusters have already been flown on American-built spacecraft such as Telstar-4 and are planned for use on Intelsat VIII. Europe is also heavily involved in electric propulsion. European systems, whose development has been sponsored by ESA and various national space programmes over the last two decades, will shortly reach the flight operational phase.

Amongst other electric propulsion activities, ESA has supported, in the framework of ASTP-3, a comprehensive

programme of research into magneto plasma dynamic (MPD) and medium-power arcjet thrusters and the first development in Italy of a low-power arcjet system.

An arcjet system uses energy of an electrical arc discharge to heat a propellant gas which is then accelerated by gas-dynamic expansion in a nozzle. In an MPD thruster, electrical energy released by an arc discharge creates a neutral plasma which is expelled at high velocity caused by the interaction of the discharge current with a magnetic field. The results of work on both types of propulsion system are presented in this article.

Low-power Arcjet Technology

Low-power arcjet thrusters, working at power levels between 0.5 and 2 kW, produce a much higher specific impulse than conventional chemical propulsion systems, which brings substantial savings in the mass of fuel needed to fulfil a mission. In addition, they are less complex than other electrical thrusters.

The use of arcjet thrusters with monopropellant or bipropellant hydrazine fuel systems can simplify the integration of a spacecraft. Nor do arcjet thrusters produce strong electrical interference, and the electromagnetic compatibility of arcjets with on-board telecommunication systems has been successfully demonstrated. Arcjet electric propulsion systems are therefore particularly attractive to use.

ESA has sponsored the development and testing of low-power arcjets at BPD Difesa e Spazio and at Centrospazio. Work comprised the design and performance testing of two different advanced, laboratory model, radiation-cooled, low-power arcjets, named Mod-A and Mod-B The testing activities at Centrospazio have been focused on definition of the operational envelope and mapping parametric performance using nitrogen, hydrogen and mixtures of these gases on the Mod-A thruster (Figure 1) [not reproduced].

The test activities at BPD included parametric performance mapping on the Mod-B thruster, using nitrogen, hydrogen, ammonia and mixtures of these gases, testing with catalytically decomposed hydrazine and endurance testing (Figure 1).

Both engines were designed to simulate the thermal characteristics of flight-type engines and to enable simple exchange of the critical parts for parametric testing. Figure 2 [not reproduced] shows the Centrospazio thruster during the firing phase.

In the framework of this programme, test facilities have been procured, installed and commissioned at the premises of both contractors.

Test results have shown that both arcjet thrusters performed well, in terms of specific impulse, efficiency and thermal behaviour when fed with a variety of propellants.

The achievements of this contract form the basis of future European activities in this promising technology.

MPD Thruster Technology

A broad-based experimental investigation of gas-fed magneto plasma dynamic thrusters, operating in the pulsed mode has been carried out at Centrospazio.

Although the instantaneous electrical power needed to run an MPD thruster is very high, of the order of several megawatts, working the thruster in pulsed mode reduces the mean power level to typically less than 1 kW, whilst still maintaining a thruster performance comparable to that of arcjets and large ion engines.

A thorough understanding of pulsed MPD thrusters can support future developments in which electrical power is continuously supplied to the thruster. The most important applications of this technique will be found in ambitious future space missions involving inter-orbit transfer of very large space vehicles. These will require an efficient thruster which produces high specific impulse under continuous operation.

An MPD thruster family has been designed and manufactured at Centrospazio to investigate the effect of geometry and scaling on performance.

Tests have been carried out on different thruster configurations at different mass flow rates of the argon propellant and at different power levels. Electrical and thrust characteristics were measured.

In addition, Centrospazio has developed a unique cathode heating system which allows the simulation of steady state thermal conditions, while working in pulsed mode. The prototype has a ring anode configuration and the cathode is heated by an electrical arc established between an internal electrode and the inner surface of the cathode itself.

Figure 3 [not reproduced] shows a sequence of events during the cathode warm-up phase of the MPD thruster. Preliminary comparison of results obtained from testing thrusters with and without a cathode heating system have shown that cathode heating significantly improves the operational performance of the thruster and reduces the cathode erosion rate.

Conclusion

Arcjet and MPD thrusters have been developed and tested under ESA funding and these activities have created a basis for further development of these systems.

Low-power arcjets may soon be qualified for use on European commercial and scientific satellites in the near term.

Further developments will be carried out in the framework of the technology development programmes of both ESA and the Italian Space Agency, ASI.

ESA Testbed for Space Robotics

94WS0486B Noordwijk PREPARING FOR THE FUTURE in English Jun 94 pp 6-7

[Article: "External Servicing Testbed for Automation and Robotics": F. Didot, Control Robotics and RVD Division, ESTEC; G. Colombina, A. Rusconi, Tecnospazio; G. Magnani, Politecnico di Milano]

[Text]

Contractors Tecnospazio

Funding Laboratories and Facilities Investments Budget

Introduction

Current planning for the international space station requires its in-orbit assembly and servicing to be done by robots. In this context, the European external robotics arm (ERA) is seen as an important contribution which will be used for servicing a section of the international space station to be provided by the Russians.

Unlike terrestrial robots, the ERA will use advanced exteroceptive sensors, such as a vision-based proximity sensor which monitor the motion of the arm relative to an object, or the force and torque sensor which is used while contact between the arm and the target is being established.

To perform a movement correctly, the robot controller must be able to move the arm or exert a force along any chosen axis, tailor the dynamic response to an external disturbing force, and follow the movement of an object at a fixed offset (proximity motion), features which are not normally available in industrial robot controllers.

However, the C3G controller, recently developed by Comau provides an "open controller mode" through which expanded capabilities may be obtained by connecting it to a computer. The open controller mode provides a latent capability for new developments, the possibility to evaluate and implement new control functions and algorithms, while ensuring the benefits of a robust, reliable controller at an affordable price.

For these reasons, the C3G controller was selected as the core of "Estar" (External Servicing Technology Testbed for Automation and Robotics).

Purpose of Estar

Estar has been built for evaluating specific control algorithms and for demonstration and continued assessment of the results of studies carried out under the Agency's Basic Technology Research Programme. Estar will be mainly used to support the External Robotic Arm (ERA) project.

Estar Testbed Configuration

Figure 1 [not reproduced] shows the main components of Estar whose main components are:

—an anthropomorphic, 6-degrees-of-freedom, Comau Smart 6-125 industrial manipulator;

—a force and torque sensor, used for contact motion;

—a laser distance sensor, used during proximity motion;

—a personal computer linked to the robot controller via a dedicated data bus.

Estar Testbed Capabilities

Although the testbed can do much more, the exchange of a standard equipment box called Orbital Replaceable Unit (ORU) was performed, since this allowed all required robot functions to be demonstrated in a single operation.

The functions performed by the robot were:

—*move*: the robot end effector is placed above its target;

—*approach*: feedback from the distance sensor is used to align the end-effector to a target whose position is initially not exactly known;

—*grapple*: The ORU is firmly grappled by the "gripper" mechanism of the robot;

—*yield*: the robot arm complies with external forces and torques, to compensate for residual geometrical misalignments between the gripper and its grapple fixture;

—*insert*: the arm complies with external forces and torques, to compensate for misalignment along the guide path, thus avoiding jamming.

Compliance Control

As mentioned earlier, the arm has a force and torque sensor which enables it to react to external forces and torques. The way in which the arm reacts to force and torque depends on the functions required of it. For example, for the *yield* function, the arm behaves as a pure damper, whereas for the *insert* function, it behaves as a damper and a spring element. For the Estar testbed, the *insert*, *extract* and *yield* functions are implemented using the impedance controller whose block diagram is shown in Figure 2 [not reproduced].

The operator of the robot can select the task frame, for example by defining the axes along which the control parameters will act, and by defining the values of each of the gain parameters **K**, **B** and **M**. The parameters may be purposefully tuned to define the characteristics of the movement of the robot.

Proximity Control

To position the gripper accurately with respect to its grapple fixture, the location of the tip of arm relative to the target must be fed back to the controller. For this, a laser distance sensor is used to compare the expected target location to the real target location. The Cartesian position of the arm is automatically changed to reach the target.

Figure 3 [not reproduced] shows the implementation of the proximity loop.

Programming Interface

The programming interface has been written in the PDL2 language, which takes full advantage of the capabilities of the C3G controller, and enables easy connection to an off-line programming system for preparing and executing complete automatic sequences. Thus the controller also provides a unique standard user interface, with which the personal computer acts as a co-processor.

Results

A complete ORU exchange sequence has been performed, using the dedicated functions implemented to perform proximity sensing and contact motion.

As part of a test sequence, geometrical misalignments (typically 5mm and 0.5 degrees) were deliberately introduced

during the initial phase of payload insertion. These misalignments produced forces and torques along the insertion trajectory. By sensing them, the manipulator was able to compensate for their effects, until the measured forces and torque errors had been reduced to less than programmed threshold values.

During grappling, the initial gap between the gripper and its grapple fixture was compensated by the *yield* function. At the end of the grappling manoeuvre, the residual contact force and torque between the arm and its environment was of the order of a few Newtons.

The feedback provided by the proximity sensor made it possible to position the arm with an accuracy +/-0.1 mm.

Conclusion

The Estar testbed provides a state of the art environment for testing. Its open controller structure has proved to be flexible enough to integrate new control algorithms (proximity motion, compliant motion), that are not available in standard industrial robot controllers. The capabilities of Estar make it a key element for supporting the ERA project. Estar is a tool which supports a comprehensive performance evaluation of a complete robotic workcell including all control aspects, end-effectors and the payload with its mechanical interfaces.

ESA Laboratory Tests Radio Frequency Space Hardware

94WS0486C Noordwijk PREPARING FOR THE FUTURE in English Jun 94 pp 8-9

[Article: "The Radio Frequency Systems Laboratory at ESTEC": S.J. Feltham, Radio Frequency Systems Division, ESTEC"

[Text]

Introduction

The Radio Frequency Systems Laboratory at ESTEC is responsible for measurement and characterisation of radio frequency hardware intended for spaceborne and ground systems. Our support to ESA projects and technology programs is unique because we can provide specialised measurement and calibration techniques which are not available in industry. The activities of our laboratory include testing of microwave systems, subsystems, equipment and components intended for remote sensing, communications, navigation and science missions.

There is also an increasing demand from outside ESA for the specialised skills and expertise we can offer. Recent commissions included multipaction testing of Intelsat 8 waveguide components for DASA (D). This article reviews briefly some of our past achievements and our future plans.

Earth Observation

Future Earth observation programmes will address not only environmental issues but also management and monitoring of resources. This requires the development of new techniques and new instrumentation for passive and active microwave remote sensing from satellites. Our laboratory will be closely involved with these developments.

The European Remote Sensing satellite (ERS-1) has produced valuable data since its launch two years ago. Its successor, ERS-2, is scheduled for launch at the end of 1994. A main activity of the laboratory is the deployment and maintenance of on-ground transponders needed to calibrate the synthetic aperture radars and the scatterometer instruments of the ERS satellites during flight.

Three active radar calibration (ARC) transponders have been designed and manufactured in the laboratory and are now used as ground reference standards for ERS-1 (Figure 1) [not reproduced]. They are placed at accurately known locations in Spain and the Netherlands where they can be simultaneously observed by the radar on fly-by. In response to the signals sent by the radar, they transmit standard return signals which show up as point targets, thus calibrating the location and detection properties of the radar. Recognised as a world standard, these transponders are calibrated using a novel technique developed within ESA.

The Polar Platform will be used for two Earth observation spacecraft, Envisat and Metop. Our support to these projects will include testing for multipaction and passive intermodulation products at high power, component evaluation and instrumentation development. An advanced autonomous range and target simulator (ARTS) is currently under development, as a test tool for the advanced synthetic aperture radar (ASAR) currently being designed for the Envisat satellite. In addition, transmit-receive modules and beam forming techniques for the active antenna of ASAR will be tested. Plans for a second generation ARC, for dual-polarisation radars, are underway.

Telecommunications

Recent years have seen a move from analog towards digital transmission methods for satellite communications. Methods for evaluating digital compressions techniques will be evaluated. We will also test equipment evolving under the Agency's technology development programmes, particularly for the 20 to 30 GHz region of the spectrum, and a test set to measure passive intermodulation products at Ka-band will be established.

The high frequency capability of the laboratory will be progressively extended to 50 Ghz, 75 Ghz and later to 110 Ghz to cover the millimetre-wave spectrum. A high power test on a 4-by-4 Butler matrix operating at Ku-band is under preparation to determine the feasibility of using this design for future missions.

Mobile communications is a growing activity. Test beds are planned for evaluating, amongst other things, antenna beam-forming networks and the channel-routing and on-board processing used by advanced mobile communication payloads. Miniaturised hardware is often essential to a mobile system.

Testing application-specific integrated circuits and monolithic microwave integrated circuits will become an

increasing important activity of our laboratory. Our on-wafer probing and microwave integrated circuit assembly facilities are already extensively used to assess in-house circuit designs and to evaluate European device foundries.

Our support to Artemis, a first generation European data relay satellite, includes evaluation of elements of the high data rate terminal and assessment of radio interference on communications links between low earth orbit, data relay satellites and ground (Figure 2) [not reproduced].

Navigation

Usage of the international global navigation satellite system GNSS, is growing rapidly. Of particular importance, because of the commonality to all ESA satellites, are applications involving spacecraft navigation and precise positioning.

Our laboratory is already active in evaluating GNSS receivers, monitoring the GNSS satellite constellations, performing system simulations and investigating future applications.

Science Missions

Our support to the ESA Science Programme is limited to providing services which are not available in industry. Potential involvements include the evaluation of navigation systems for the Mars rover, high temperature components, communication systems for operating in a high noise environment close to the Sun, deep space transponders, data compression and advanced modulation techniques.

Time and Frequency

Time can be measured with more precision than any other physical parameter. This is an important technological asset. Under the overall responsibility of our laboratory, an ESA external Time and Frequency Laboratory has been established at the Observatory of Neuchatel (CH). This will be described in a future article.

Other Activities

Other activities within our laboratory fall into the category of in-house developments, life testing, student training and external testing.

A major in-house development is the manufacture and test of a Ku-band adjustable beam forming network (ABFN) comprising of 32 active elements (Figure 3) [not reproduced]. Electronic beam steering offers the advantage of quick response to changes in communications traffic.

Conclusion

The Radio Frequency Systems Laboratory at ESTEC is well equipped to support the development and evaluation of advanced systems, and provides this support to projects and technology development programmes which are both internal and external to ESA.

British National Space Center Contributions to ESA Programs

94WS0486D Noordwijk PREPARING FOR THE FUTURE in English Jun 94 pp 18-20

[Article: "British Space Technology—Looking to the Future": M. Blackwell, British National Space Centre, (UK)]

[Text]

Introduction

No space programme builds itself. It needs advice, encouragement, sponsorship, and reliable links to parallel and complementary programmes. Within the United Kingdom, these are largely provided by the British National Space Centre (BNSC), which not only focuses Britain's values as an ESA partner, but supports the underlying national space technology framework and helps the UK space sector compete internationally.

BNSC sponsors a comprehensive technology programme, and much of the research and development it supports is highly innovative. I aim to highlight just some parts of the programme—in this article we look at UK innovation in materials, energy collection, power, radiation-hard chips, computing, propulsion, and simulation; in particular, at titanium structures, solar cell cover glasses, gallium arsenide cells, ASICs, embedded software support, developments in computer systems, ion propulsion, and satellite manoeuvring. Each of the programmes listed has been supported by BNSC.

Materials

The forming of structures for use in extreme environments such as space, demands light and very strong materials. In response, space programmes throughout the world have turned to the metal titanium. Dowty Aerospace, Wolverhampton, has developed, fabricated and qualified ultra-light titanium propellant tanks for ESA's Cluster programme.

In carrying out this work (for British Aerospace, the Cluster propulsion subsystem contractor), Dowty made extensive use of computer aided design tools in environmental and structural assessment, and carried out a comprehensive qualification series of cryogenic proof pressure, sine and random vibration, static acceleration, pressure cycling and burst pressure tests. Each tank has a dry mass of just 6 kg, coupled with an internal volume of 97.9 litres, and each can be loaded with up to 135 kg of propellant at 23 bar maximum operating pressure. Figure 1 [not reproduced] shows a Dowty tank integrated on one of the Cluster spacecraft at British Aerospace.

Energy Collection

Solar power collection makes heavy demands on materials. While each photo-voltaic solar cell must be able to collect energy efficiently, it must be protected from particle and ultraviolet radiation damage, and the cell must run at as low an operating temperature as possible.

Pilkington Space Technology has developed a new optical coating for solar cell coverglasses, which additionally reflects infrared energy (providing a real advance in anti-reflection coating). In-orbit efficiency gains of 5 percent are predicted, especially for non-reflective silicon cells; useful gains are also predicted for gallium arsenide cells. The company's development of teflon bonding has been extended to provide an economic method of eliminating

surface electrostatic discharges, and poses a strong challenge to the current silicon based processes.

Gallium Arsenide Solar Cells

EEV Ltd. has become the leading UK authority on gallium arsenide solar cell technology. Such cells offer typically 50 percent more power per unit area when compared with the best silicon panels, and by 1993 the UoSAT-5 satellite (designed and built by the University of Surrey) powered by gallium arsenide cells, and already in orbit for over two years, was clearly demonstrating the superior resistance of such cells to the space environment (Figure 2) [not reproduced].

On-going EEV development programmes are expected to lead to the qualification of lower mass gallium arsenide-on-germanium cells up to 40mm square during 1994, and in the medium term to the improvement of gallium arsenide efficiencies beyond 22 percent AMO in the space environment.

Radiation-hard Chips

The Rutherford Appleton Laboratory (RAL) Micro Electronic Design Group has developed more than forty custom-built radiation-hard semiconductor devices for industry, high energy physics and space research. The devices range from low-noise, low-power CMOS analogue chips for sensors, to large digital integrated circuits for signal processing, and they have been successfully used in such projects as ESA's Cluster and Integral programmes, and in NASA's Polar mission.

The chips greatly enhance the market range. RAL's efforts in meeting ESA and NASA product assurance requirements have targeted considerable expertise to ensure the radiation-hard chips have strict reliability built in.

Electronics

The constant growth in spacecraft and systems complexity makes ever greater demands upon computer hardware and software. Logica Space and Communications has been helping meet these demands through its HESSE and ERC32 programmes. MA31750 HESSE (hard real-time embedded software support) complements advanced real-time analysis, providing tools to support use of the radiation-hard MA31750 processor; the programme is designed to analyse whether hard real-time applications can meet developers' critical deadlines.

The ERC32 Microprocessor and Computer System Development is a 32-bit microprocessor development programme. Again with deadlines in mind, a cross-compilation system for the ADA programming language is being specified and designed for onboard applications and to analyse worst-case timing behaviour.

Simulation and Control Software

The very high cost and complexity of spacecraft operations demands that training be supported by sophisticated ground-based simulators. Cray Systems has therefore developed VISIM, a software package which enables operators to monitor three-dimensional simulations of spacecraft attitude manoeuvres. VISIM has an advanced "Motif," windows-based, MMI. Its funding was partly provided by ESA's space operations centre, ESOC. VISIM has been installed at ESOC and is in use within the Infrared Space Observatory (ISO) project.

Cray also provides consulting and engineering services to ESA covering software development for control circuits, simulators, planning tools, communications and ground station systems.

Science Systems (Space) Ltd. has developed a kernel satellite control system to provide monitor and control facilities. This system, which can be configured for missions of any complexity, will simultaneously support a number of satellites. It has been used for some years on a UK Ministry of Defence programme, and has been selected for other missions including Hispasat, Telecom-2, Orion and Eumetsat's Meteosat Transition Programme.

This company also provides consultancy services to ESA in a number of other areas, including flight dynamics and image processing.

Ion Propulsion

ESA's plans for satellite electric propulsion mean British UK-10 ion thrusters will provide the Artemis communications mission with much of its north-south positioning capability. The Artemis Prime Contractor, the Italian company Alenia Spazio, is contracting provision of the UK-10 engines (developed by BNSC partners the Defence Research Agency (DRA) and AEA Technology) from Matra Marconi Space.

In the UK-10, xenon propellant is ionised in a direct current discharge between an axial hollow cathode and a cylindrical anode, within a diverging magnetic field, then the positive ions are extracted and accelerated by a high electric field to provide a specific impulse of some 3500 sec. The Artemis mission calls for a thrust of 18 mN from the UK-10, which has already been qualified for 25 mN. Figure 3 [not reproduced] shows the ion beam emerging at 40 km/s in a DRA test facility.

DRA Programmes

During 1992-3 DRA carried out a number of BNSC-sponsored research and development programmes. These included re-entry prediction for two CIS PION satellites (in conjunction with Mission Analysis Section of ESOC), and analysis of the potential pollutive impact of satellite systems on the orbital environment, which has implications for the growing population of space debris.

Conclusion

BNSC is committed to nurturing technology research and development within the UK, and to this end provides a wide range of support to public and private sector programmes.

Europeans Consider Ariane 5 Upgrades, Cooperation With Russia

94WS0446A Stuttgart FLUG REVUE in German Jul 94 p 75

[Article by Goetz Wange: "Development Opportunities for Ariane 5"]

[Text] The first Ariane 5 rocket has not yet been launched. But already the industry is thinking of greater power. The objective is a cooperation with Russia.

From a commercial aspect, the European payload rocket program Ariane is the most successful in the world. The prescription: In one launch the rocket can place at least two communications satellites into a geostationary orbit at the same time. The European system thus has an advantage over the less powerful launch systems from the United States, China and Japan. But it is already evident that the competition will soon catch up. In parallel, analyses show that the weights of the communications satellites will continue to increase. Unless Ariane 5, which after 1985 will carry about 6.8 tons into a geostationary orbit, is further developed, the advantage of the double launch capability could be lost. "Every seven years an increase in capacity is necessary," stated Roger Vignelles, head of the French engine firm of Societe Europeenne de Propulsion (SEP), at the end of April in a talk to the German-French Society for Science and Technology in Bonn.

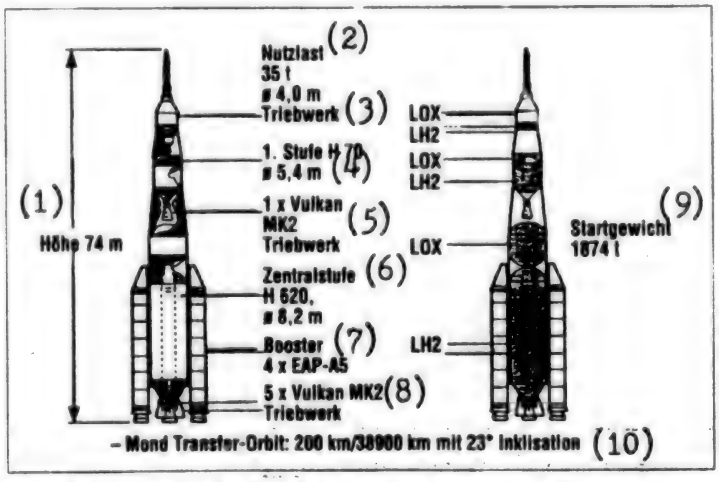
At the industry work has been under way on the Vulkan MK2 version for about a year. Changes to the turbo pump, the gas generator and the jet nozzle will yield an increase in the specific impulse. For the Ariane 5 launcher the result is an 850-kg increase in capability. The MK3 and MK4 engine versions could later appear with an entire series of technical improvements, with which the Ariane could first carry 1,400 kg, and later as much as 2,050 kg more than today, into geostationary transfer orbit.

To Roger Vignelles these steps are logical. But he also knows that the budgets will only be made available if the industry can make it clear that the investment pays off. "We have thought through our concepts very well. In developing the Vulkan MK2 into the MK4 there will at the outset be no technology that would be replaced by later development steps," the SEP head explains the strategy.

The Frenchman is in agreement with his colleagues from the other European aerospace engine firms—German Aerospace, Fiat Avio, Techspace Aero and Volvo Flygmotor. In the next few days the above companies are going to sign an agreement which assures the development of powerful space flight engines beyond the year 2015.

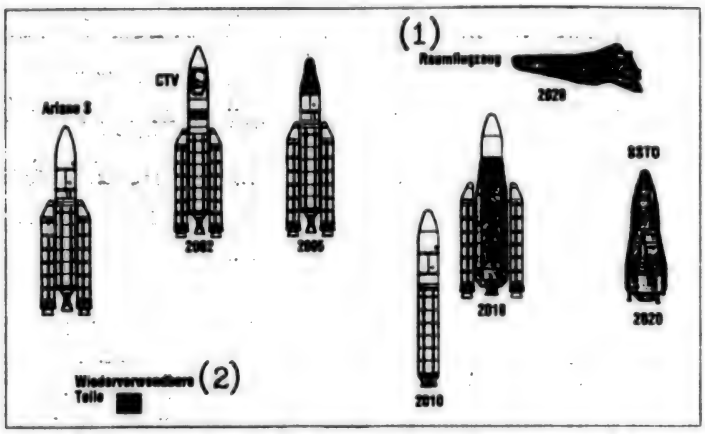
The period of time contemplated by the industry indicates that missions other than just to LEO [Low Earth Orbit] and GEO [Geosynchronous Earth Orbit] must also be served. An example is ESA's [European Space Agency] moon initiative. Based on Ariane 5, a 74-m-high launcher with a launch weight of 1,874 tons could be developed. With a diameter of 8.2 meters, the tank in the central stage would be significantly larger and could supply five Vulkan MK2 engines with liquid hydrogen and oxygen. The 35 tons of payload which could be got under way to the earth's satellite would sit on an upper stage, which would have to be equipped with a restartable engine of the ACE class.

All these so-called "throw-away rockets" have the disadvantage, however, that—despite the new technology—today's launch costs could only be reduced by about 10 percent. In the long term, Europe must therefore take a stronger approach toward reusable systems. By the year 2020 they must show whether one-stage, reusable launchers (SSTOs) or space shuttles will win the race.



This is the potential design for a heavy payload rocket, based on the Ariane 5 technology, which flies to the moon

Key: 1. Height 2. Payload 3. Engine 4. First stage 5. 1 x Vulkan MK2 engine 6. Central stage 7. Booster 8. 5 x Vulkan MK2 engine 9. Launch weight 1,874 t 10. Lunar transfer orbit: 200 km/38,900 km with 23° inclination



The steps from a "throwaway rocket" to reusable space transporters in the year 2020

Key: 1. Space shuttle 2. Reusable parts

As for the technologies of such engines, the United States and Russia have a considerable lead in know-how. The European aerospace industry would therefore start a technology program with the Russians beginning in 1993 [sic]. For this, Russian engines—the RD 0120 from Energiya or the D-57 from the N-1 moon rocket—will be used as a demonstrator. In the first step Western sensors will record the performance data. These data become part of a design model for a Western European engine, whose functions can be tested in other demonstration missions.

About 40 million German marks are needed within ESA for the first three years of the RECORD (Rocket Engine Cooperation on Russian Demonstrator) program. France is ready to assume 60 percent of that. Germany would participate with 15 percent.

Despite the now very shrunken national budget, the German aerospace agency DARA is favorable to the proposal.

Laminar Flow Wing for Dassault Bizjet

94WS0446B Stuttgart FLUG REVUE in German Jul 94 p 77

[Article by Heinrich Hemker: "Falcon 900 With Laminar Flow Wings"]

[Text] Dassault Aviation has equipped a Falcon 900 with a hybrid laminarized wing in order to prove the everyday usefulness of the concept.

The experimental laminar flow wing of the Falcon 900 from French business jet manufacturer Dassault Aviation has successfully completed its first flight test. On 12 April the aircraft took off from Bordeaux-Merignac airport with Yannik Colass and Guy Mitaux-Maurouard at the controls.

With that, the first step of transferring the principle of hybrid laminarization into the practice of daily flight operation has been completed at Dassault. When the flight tests with the modified aircraft are completed, it will be incorporated as a charter aircraft into the Dassault Falcon Service with a special airworthiness certificate. It will then be proved over a long period of operation that synthetic lamination creates no problems even under the conditions of rough everyday operation.

In order to laminate synthetically the flow around a sharply swept-back airfoil such as the Falcon 900, it is not enough to give it a corresponding profile. It is also necessary to draw off the boundary layer in the critical leading edge region. This is why the Falcon 900 was given a new skin of composite materials in the internal region of the airfoil which is equipped with a large number of laser-drilled holes. These holes are conical, and therefore expand toward the interior, which is why it is almost excluded that they could become clogged with dust particles. The space under the outer skin is furnished with a jet pump using piping, which in turn is driven by engine bleed air.

The removal of the boundary layer works exclusively during cruising. The deicing system was modified, and a liquid system is now being used.

In comparison with the Falcon 900 series design, the hybrid laminarized interior region of the airfoil has an air resistance that is about 15 percent lower. Dassault expects that with the laminarized wings it will be possible to achieve a considerable increase in range or a corresponding reduction in fuel consumption.

Germany's DASA Develops High-Performance Solar Cell for ESA Spacecraft

BR0208145994 Rotterdam NRC HANDELSBLAD in Dutch 9 Jun 94 p 6

[Article by George Beekman: "High-Efficiency Solar Cell for Use Far From Sun"]

[Text] Recently, the European Space Agency [ESA] announced that it had developed a high-efficiency solar cell.

It was claimed that this cell could convert 25 percent of the sunshine in space into electricity. A report like that attracts attention, because the efficiency of solar cells used on the Earth is around 15 percent.

At the conference on solar cells held in Amsterdam in April, Japanese researchers reported that they had confirmed the attainment of a new record of 16.5 percent, using very thin cells. Could the Europeans have made a miraculous leap forward to 25 percent?

The new solar cell was developed to provide energy for space probes that conduct research at great distances from the sun. At such distances, the sunlight is so weak that the solar cells currently available cannot generate enough electricity. A few years ago, the ESA launched a program aimed at developing (affordable) solar cells that would be able to meet these requirements. This research is being conducted under the supervision of DASA (German Aerospace).

One of the research laboratories involved is the "Solar Generators" Department at the ESTEC space center in Noordwijk. Klaus Bogus, the head of this department, immediately began by pointing out that the reported 25 percent cannot simply be compared directly with the efficiencies achieved by solar cells on the Earth. "The sunlight that we collect here has come through the atmosphere. It is both attenuated and filtered, and contains only a fraction of the full spectrum of solar radiation. In space, sunlight is not weakened in this way, and the solar cells capture the solar radiation in its entirety," he explained.

So two different standards are used when it comes to taking measurements. In addition, the Earth-based solar cells work at a temperature that is normally above—and sometimes far above—freezing point. Solar cells in space work at much lower temperatures. For instance, the temperature around Jupiter is supposedly somewhere in the region of -100°C. At that kind of temperature, all physical properties of conventional solar cells are altered.

"All this makes it extremely difficult to compare the efficiency of Earth-based solar cells with those used in space," said Bogus, adding that although attempts are being made to develop international standards with a view to enabling straight comparisons after all, not much progress has been made so far. Bogus himself has already suggested that the large ESTEC sun simulator, in which satellites are tested, be made available as the standard source.

In the past, energy supplies for space probes functioning at great distance from the sun depended on so-called RTG's [Radio-isotopic Thermoelectric Generators]. These generators, which were originally developed for military purposes, exploit the decay of radioactive plutonium. The warmth this generates is converted into electricity by thermoelectric elements. RTG's work for a very long time, a fact borne out by the fact that Pioneer-10, which was launched in 1972, is still generating electricity.

Plutonium

To begin with, this technology was not available in Europe, and later on there was thought to be little point in developing it further. Bogus said: "This would mean that nuclear reactors designed especially to produce plutonium would have to be built. Bearing in mind the strict safety aspects involved, this would represent a project costing billions. What is more, it would also raise the problem of social acceptance." As a result, it was decided to continue developing solar cells.

The solar cell now developed by DASA-Telefunken Systeemtechniek consists of two semiconducting layers of silicon. The upper edge has a rough surface and an antireflective coating, providing a maximal light-absorbing capacity. Beneath the base is a reflective layer which reflects the non-absorbed sunlight. The fine metal mesh which picks up the current masks just 3 percent of the light (as against 5 percent in conventional solar cells).

At a temperature of -100°C and with a solar constant of 0.11 (150 W/square meter), this cell achieves 25 percent efficiency. So although this percentage cannot be compared directly with that achieved by Earth-based solar cells, the ESA claims that it can talk of a "new milestone" being reached. The ESA foresees this solar cell being used to generate electricity for space probes sent far out into the solar system. This is important for the projects that the ESA has in the pipeline. And the technology may also prove to be important for space flights closer to home, or for Earth-based applications.

One of the ESA's deep space projects is Rosetta, a space probe which, early next century, will "fly alongside" a comet near Jupiter for a period of one year. Originally, this project was going to be implemented by the U.S. space organization NASA, but two years ago it announced that it would have to withdraw due to cuts. As a result, the energy source that NASA was going to provide, an RTG, was no longer available. Rosetta will now receive four solar panels, with a total surface area of 48 square meter. At the distance from the sun of Jupiter, it will supply a total electrical capacity of 472 W, more than enough to keep the probe and its measuring instruments in operation.

Germany: DLR Plans to Launch Probe to Comet Virtanen in 2003

94WS0457B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 11 Jul 94 p 10

[Article by "re": "Landing on a Comet"]

[Text] Frankfurt—A probe is to land on a comet for the first time in the history of space flights. DLR [German Research Institute for Aerospace] in Cologne-Porz reports that the first preliminary tests are getting under way now at DLR for this unusual mission called Rosetta, whose launch is planned for the year 2003. Max Planck institutes are also taking part in the project. The eight-year journey will be to the comet Virtanen. The exploration results can be expected in the year 2011 at the earliest.

One of the first tasks is to make in DLR's space simulation chamber at around -180°C an artificial comet out of a mixture, put together on the basis of theoretical calculations, of ice, minerals and other substances. Its surface

structure is of particular importance here, because the landing device has later to anchor itself in the ground by means of barbs, because such a small celestial body exerts no force of gravity worth mentioning.

According to the plans, Rosetta will release the Roland landing device, which the probe proper, which will be equipped with additional instruments, will orbit around the comet. Then the data are to be transmitted to the earth over a distance of several hundred million kilometers. DLR's Institute for Space Simulation has been engaged in comet research already for several years now. DLR reports further that the exploration of comets is of high scientific interest, because they have changed only slightly, at least inside. Thus, researchers are hoping for insights into the beginnings of our solar system. It is also thought that the majority of the water of the earth's oceans comes from comets.

France's INTESPACE to Test Italian, Israeli Satellites

94WS0477A Paris AFP SCIENCES in French 21 Jul 94 pp 7-8

[Article: "Two Italian and Israeli Satellite Test Contracts for INTESPACE"]

[Text] Paris—It has been announced in a communique from the company that INTESPACE, a Toulouse-based company that specializes in providing services and engineering, has just concluded two contracts to conduct space environment simulation tests on the second flight version of the Italian satellite, Italsat, and on the Israeli satellite, Amos. The two satellites are to be placed in orbit by Ariane rockets in 1995.

Realized under the project management of Alenia Spazio for the Italian Space Agency (ASI), Italsat-2 is a telecommunications satellite, like Amos, built by Israel Aircraft Industries for the Israeli Government. The tests on Italsat-2 are expected to take six months during the second half of 1994. The tests on Amos, lasting two months, are planned for the first quarter of 1995.

The installations of INTESPACE (Engineering and Tests in Space Environment, average annual sales volume: 105 million French france), a commercial company whose shareholders are CNES [French National Center for Space Studies], SOPEMEA [Aviation Equipment Improvement Company], MATRA-Marconi-Space, AEROSPATIALE [National Industrial Aerospace Company], and ALCATEL [Alsatian Company for Atomic, Telecommunications, and Electronic Construction] Space, are located at the CNES Space Center in Toulouse.

French Space Agency Director Views Future

BR0308091494 Paris LA TRIBUNE DESFOSSES in French 15 Jul 94 p 9

[Interview with Francois Kourilskiy, director of the National Center for Scientific Research, by Sophie Seroussi; place and date not given: "Francois Kourilskiy: 'The Opening Up of the CNRS is Irreversible'"]

[Text]

[Seroussi] Are you leaving as head of the National Center for Scientific Research [CNRS] with the feeling that you have accomplished your 6-year mission?

[Kourilskiy] When I arrived, I was assigned a very precise role: that of opening up the CNRS to the outside world by modernizing it and giving greater flexibility to a body that some people, at the time, were thinking of dismantling. The CNRS was criticized for living in an ivory tower while devouring its 12-billion French franc [Fr] budget, which represented two-thirds of the French public research budget. Six years later, 17 regional delegations have been created and they work autonomously where most decisions are concerned. The number of cooperation agreements with companies has increased fivefold, rising from 700 in 1988 to 3,500 in 1994, and generating 700 licensing contracts. A European office has been created in Brussels and the number of associated European laboratories in the twelve Member States has increased markedly. When I first took up my post, I would meet two or three times a year with my counterparts in Germany, the UK, Spain and Italy. Now, hardly a week goes by without us meeting or calling each other. New laboratories have been created in eastern Europe and even in Japan. The CNRS is now well and truly opening up and the process is irreversible. The appointment of Guy Aubert as my successor—someone who is anything but an introvert scientist—can only help spur us on in this initiative.

[Seroussi] Have the strategic plans laid down helped to change attitudes?

[Kourilskiy] Without a shadow of a doubt. Previously the seven research departments each had their own development plans. Now the CNRS has its own strategic plan which is drawn up every three years on the basis of the report on the economic situation and future prospects. This method, which has already been used twice, in 1991-93 and 1993-95, is training the teams to think at a multidiscipline level. The four priority research subjects selected for the latest plan prove this. Some correspond to society's main expectations such as the environment, town planning, labor, and employment.

[Seroussi] Why did you insist on consulting industry for the latest development plan currently being implemented?

[Kourilskiy] To better meet their requirements. While car-making and aeronautics firms, such as Aerospatiale, Dassault, and Renault have confirmed their interest in the modelling of complex systems, a subject we are studying in detail in our laboratories, others have pointed out considerable shortcomings. Bouygues, Sanofi, Bull, and Lyonnaise des Eaux would all like the CNRS to step up research in microbiology, bacteriology, and materials, built around a man-machine interface. In 10 years, we have managed to establish a real dialogue with industry and we now have to build on this.

[Seroussi] Do you think that the wish of your successive supervisory ministries to formalize their relations with scientific bodies in the shape of contracts meets the requirement of integrating research with the modern world?

[Kourilskiy] Absolutely. However, these contracts are difficult to set up. It is not that the research bodies jib at the prospect. On the contrary, many of them, from the Atomic Energy Commission to the National Research Institute for Computing and Automation and the French Sea Research Institute, have set up action plans that bear a marked resemblance to our strategic plans, sketching the outlines of future contracts. However, if a body makes commitments to carry out a specific mission, then the state must undertake to finance them. It will doubtless be the job of my successor to sign the CNRS's first contract of aims with the state.

Italy: Biopan Experiment Transported on Russian Capsule

MI1808143094 Rome SPAZIO INFORMAZIONI in Italian 1-15 Jul 94 pp 4-5

[Text] Moscow, 11 July. The orbiting mission of the Photon-9 Russian space capsule was successful. It was launched from the Plesetsk (Russia) base on 14 June and retrieved on 2 July after landing in Kazahkstan. The Photon-9 (weighing about two tons and placed in a low orbit 340 kilometers from the Earth) transported the Biopan scientific container, built by Kayser Italia of Leghorn for the ESA [European Space Agency] and fitted onto the outside of the capsule, into space. This was the Biopan's second flight, its first flight having been in September 1992. The Biopan was instructed to open in orbit, 20 hours after the launch, thereby exposing the various experiments it was carrying to the effects of cosmic radiation, the emptiness of space, and the absence of gravity. During the flight in space the characteristics of some materials were studied, and the possibility that living organisms can "migrate" from one planet to another, travelling through space (carried by example by a comet) and causing life to begin where it did not exist before, was also verified.

The Biopan was put into orbit by a team of young, highly specialized technicians from Leghorn (Mr. Fantozzi was responsible for the hardware, Engineer Neri for the onboard software, and Doctor Norfini for the software analysis on the Earth). It took 10 days to prepare the Biopan at the ESA laboratory in Moscow and one day to fit it onto the Russian capsule at Plesetsk. All the operations, before, during, and after the launch, were directed by mission manager and Kayser Italia Managing Director Eng. Valfredo Zolesi. Furthermore, the telemetry data of the Photon-9 was also followed during the mission by the Kayser Italia laboratory using the photonet network that had been specially developed by the Italian company and that provides a direct link with the Russian Space Forces.

"The launch that put the Biopan into orbit," Eng. Valfredo Zolesi disclosed to SPAZIO INFORMAZIONI, "was the fourth that our company has effected from the Russian Plesetsk base. It followed the test flight of the Biopan in 1992, the flight of the ESA Biobox incubator in December 1992, and the microsatellite Temisat that was built for Telespazio and launched in 1993. On the strength of this experience, which is unique in Europe at present, both as regards the number of launches over such a short time and the quality of the results, the ESA entrusted the direction of the operations for this mission to Kayser Italia. Beyond the technical and professional aspect," concluded Zolesi, "this was an important recognition for a small Italian company at a time when all the space sector finds itself in difficulty."

Italian Experiments Aboard U.S. Space Shuttle Successful

MI1108090594 Milan IL SOLE-24 ORE in Italian 21 Jul 94 p 13

[Article by Francesco De Filippo: "Shuttle, Mission Complete for the MARS Experiments"]

[Text] The 62nd mission of the Space Shuttle, the IML-2 [International Microgravity Laboratory-2], scored a success for Italian scientists. The two fluid dynamics experiments (studying the dynamics of fluids) that were planned to be conducted on board the Columbia were successful. The tests prepared by the MARS [Microgravity Advanced Research and Support] consortium set up by Alenia and the Federico II University in Naples (which has its head office at Aversa near Caserta), in collaboration with the CIRA [Italian Aerospace Research Center], the aerospace research center in Caserta, were carried out inside an instrument built by Alenia Spazio, the BDPU [Bubble Drop and Particle Unit].

The MARS experiment, that required an investment of 20 billion lire, was financed by the European Space Agency [ESA]. It was an analysis of drops and air bubbles blown into a solution of tetracosane (a sort of pure wax) that has made the study of the dynamics of bubbles in varying temperature gradients possible. The MARS experiment was conducted using remote control techniques (the data being analyzed in real time in Naples) and it was controlled directly from the office in Fuorigrotta by the "principal investigator" [as published], Rodolfo Monti. It was the first time that NASA had allowed another organization to conduct an experiment on board one of its spacecraft, as was confirmed by the head of the space operations department of the ESA, Rolf Jhensson. The experiment was tried out for the first time last Friday but a breakdown caused the American engineers to switch off the equipment.

The other experiment, that of professor Antonio Viviani (the other principal investigator), was however controlled from the United States with the collaboration of co-investigator Carmine Golia (president of the CIRA). It used the connections between the MARS and the spacecraft, and, on the other hand, assured the verification of the movement of gas particles in a "bridge" of oil and silicon.

The two experiments—the data of which will be analyzed when the spacecraft returns to Earth, this being planned for tomorrow—have the goal of producing exceptionally pure materials and metals in zero gravity environments. These could be used for example in the space industry. Yesterday's experiment was the 10th experiment to be conducted in space (the second on board the Shuttle) for the MARS, and the first for the CIRA, that made its calculation and scientific visualization center available.

AUTOMOTIVE INDUSTRY

EU: First Hydrogen-Powered Bus Prototype Presented

94WS0477E Paris AFP SCIENCES in French 21 Jul 94 p 35

[Article: "Presentation of First Liquid-Hydrogen Bus"]

[Text] Brussels—The ideal road vehicle in the year 2000 will be powered with liquid hydrogen—ecologically very clean and safe—Mr. Jean-Pierre Contzen, the director of the European Union Joint Research Center, asserted as he presented the first prototype of its kind, a bus, in Geel (Northern Belgium).

The studies for and designing of the prototype, a Euro-Quebec project, the EQHHPP (Euro-Quebec Hydro-Hydrogen Pilot Project) cost about ECU45 million, co-financed by the Community budget, the Quebec Government, and some 30 private French, Belgian, German, Irish, Italian, Spanish, and Quebec companies. The combines: the French Liquid Air, the German Tyssen and German Aerospace, and the Quebec Hydro-Quebec and Novabus, figure prominently among these private firms.

The engine is environment-friendly: "The vehicle's exhausts do not expel CO_2, just nitrogen oxide," Mr. Contzen indicated during his presentation on 13 July. "What's more, at a rate 28 times less than that of a diesel engine." "Actually, you can perfectly well breathe these exhaust gases. They're water vapor!"

Its power rating is comparable to that of a conventional diesel-engine bus: It covers 400 meters in 44 seconds as against 38 seconds for the diesel vehicle. Moreover, a particular effort was made in the area of safety, Mr. Contzen added. Each bus will be equipped with an internal safety computer, hydrogen sensors, and the fuel tanks will be protected by a double, shock-resistant hermetically-sealed wall.

However, a few "details": The prototype's consumption rate is still quite generous. It is equivalent to 0.32 liters of diesel fuel per kilometer, or an average consumption rate of 32 liters per 100. Moreover, the cost per kilometer is 30 percent higher than that of a diesel-powered vehicle.

And lastly, for the moment the prototype has a range of only 70 km, although it can be extended to 300 km by expanding the volume of the hydrogen tanks. But, while liquid hydrogen is an extremely light product, it requires a storage volume three times greater than that of gasoline for the same amount of energy. The first public liquid-hydrogen buses could be placed in circulation by 1996 and the principle could be extended to private vehicles by about 2003.

More On Hydrogen-Fueled Passenger Bus Presented at EU Research Center

BR1808100094 Berlin DIE WELT in German 15 Jul 94 p 5

[Article by Norbert Lossau: "Explosive Technology From the Cold—The First Bus Operating on Liquid Hydrogen"]

[Excerpts]

[passage omitted]

At the suggestion of the European Parliament, a European-Canadian research project for the development of a passenger bus fueled by liquid hydrogen was started in 1992. Last Wednesday the first operational bus and its fueling plant were presented to the public at the EU research center at Geel in Belgium.

[passage omitted]

The storage technology for the liquid hydrogen, with a temperature of minus 253°C, and the fueling plant are the product of the German company Messer-Griesheim; the hydrogen engine, a slightly modified diesel engine, was developed by the British company Detroit Diesel. The prototype is to be used for local public transportation in the vicinity of the Geel research center. Two additional buses are planned to operate in Erlangen and Genoa in 1995. A fourth bus, equipped with a Stirling engine, will be shipped to Ireland.

Critics of the hydrogen technology refer to the extremely high flammability of the high-energy gas. The explosion of the space shuttle "Challenger," fueled with 1.4 million liters of liquid hydrogen, is still before many people's eyes. But project manager Dr. Hugo Vandenborre claims that hydrogen—if the respective safety measures are observed—is not more dangerous to handle than gasoline. Sensors would immediately detect the smallest leak, the tank is double-walled, and the bus is equipped with impact protection in the area of the tank. All safety-relevant aggregates are designed for accelerations for up to four times the gravitational acceleration (4g).

Germany: More Electronic Systems Called for in European Cars

94WS0457A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 11 Jul 94 p 10

[Article by "Scha": "Europe's Automobiles Will Be More Competitive With More Electronics. Diagnostic Systems Deserve Particular Attention; Navigation Aids Not Before the Next Decade"]

[Text] Frankfurt—No automobile maker could last long in the highly competitive market without semiconductors and the associated electronic components. About 10 companies at present share the world market for automotive electronics, including, in Germany, Bosch as the market leader before Siemens, Daimler-Benz subsidiary Temic, VDO and Hella. Automotive electronics account for around nine percent of the semiconductor market in Europe. The industry expects that this share will grow to around 12 percent within the next three years.

One reason for this is the need to catch up with the competition in the world market. While Japanese and American automobiles have already today over $100 worth of semiconductors on board, the average European automobile is equipped with only $60 worth of electronics. So,

automotive electronics are also regarded in Europe as a vehicle for growth among all chips. Growth of between 14 and 15 percent annually for the next five years appears to be a possibility.

Increasingly more complex systems are the engine for this growth. Strict environmental regulations and the highest safety standards can be met only with the latest microelectronics. Engine management, ABSs and airbags are being forced both by law and competitive pressure from Japan and the Far East, where this equipment is already almost routine.

According to studies by Dataquest's market researchers, the degree of permeation will grow up to fivefold from 1990 to the end of 1995 depending on area of application. In addition to ABSs, electronic ignition and engine management, diagnostic systems, active ride control, bus systems (an integrated control and data transfer line) as well as, to an increasing degree, anti-theft systems will contribute to this.

On the other hand, it looks like the growth in the degree of permeation of the airbag will for the time being be disappointing, in spite of the automobile makers' intensified advertising campaigns. One out of five automobiles will be equipped with this safety device by next year. On the other hand, the market researchers expect a marked share for navigation companies only after the end of the decade.

On-board diagnostic systems, with which at least one out of two automobiles will soon be equipped, deserve particular attention. They are connected to the engine management system and analyze trouble that occurs and correct it if possible. The driver can retrieve the values. Ignition misfiring in the engine area, catalytic converter values, sensors and actuators, the injection system and carburetor, in addition to the composition of the air in the interior, the turbodrive and secondary air system, for example, can be monitored.

Signal acquisition and processing, as well as diagnosis and secondary control, necessitate high requirements for electronics, so that today's processors of the 16-bit microcontroller type, which earlier seemed to be sufficient for all time, will in the future have to be replaced by high-performance RISC processors.

The expansion of electronics will in addition make possible in the future driver identification systems and anti-theft systems that are to stop automobile thieves. Kill switches that cannot be gotten past without entering a code, as well as flawless remotely activatable theft alarms, require chips having a memory capacity in the megabyte range.

Conventional and semiconductor sensors for the automobile are presently reaching in West Europe as well as in Japan a sales volume of 1.4 billion German marks [DM], and of DM1.5 billion in the United States. Speed sensors, absolute position transducers, and temperature and pressure sensors have the largest share here, whereas Europe is running behind the world competition in acceleration sensors.

The future of automotive electronics is expected to lie in the supplying of complete systems, e.g., ride control systems in which sensors, signal analysis, hydraulics, etc., will be more interlinked. "Electronica" coming in Munich (8 to 12 November) will also concern itself with this range of topics. In addition, development laboratories are working on even more complicated electronic systems that will characterize the automobile generation at the beginning of the next decade.

BIOTECHNOLOGY

Netherlands: Experiment With Genetically Altered Bacteria Approved

BR0508095794 Amsterdam DE VOLKSKRANT in Dutch 8 Jul 94 p 6

[Unattributed article: "Field Test To Be Allowed Using Genetically Altered Bacteria"]

[Text] Amsterdam—The Ministry for the Environment (VROM) has given permission to the Research Institute for Plant Diseases (IPO-DLO) to conduct a field experiment using genetically engineered bacteria. It is the first time in the Netherlands that such an experiment will have been carried out. Until now, experiments conducted outside the laboratory have made use of modified plants.

The IPO intends to sow a small area, three by four meters in size, in Wageningen with winter wheat in September. At the same time, genetically engineered bacteria will be added to the soil. In the genetic material of these soil bacteria, which belong to the common Pseudomonas strain, two genes will have been introduced from other sorts of bacteria.

One gene will make it easy to recognise the genetically altered bacteria, and to follow its growth or death. The other gene is there so that the performance of a foreign gene can be evaluated. It seems to be the case inside the laboratory, but it still needs to be demonstrated in the open field.

The aim of such basic research at IPO is in the long run to introduce genes into the genetic material in soil bacteria which have been coded for the production of certain proteins which will for instance control the voracity of the appetite of some insects. The larva of the crane fly, for instance, eats the roots of members of the grass family such as corn and wheat.

By regularly introducing such genetically engineered bacteria into the soil, it should be possible to keep an insect population under control. IPO researcher Dr. Ir. J. van Elsas expects the first proof thereof in the field within one or two years.

The test, which has now been authorized in Wageningen, will run for several years. Within a few months, after the winter wheat has been harvested, other crops will be planted. The intention is that the population of genetically engineered bacteria will be studied throughout the period.

In making this decision, the Environment Ministry has overruled objections raised by the Foundation for Nature and the Environment. The environmental organization says

among other things that the way in which the population of genetically engineered bacteria in the soil will be observed is "hazy." IPO has gone part of the way to meet them by distributing a lengthy information document. The foundation is also afraid that the "foreign" micro-organisms might spread.

COMPUTERS

UK: Cortex Expert System Operates With Pattern-Matching Algorithms

94WS0465C Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 19 Jul 94 p 10

[Article by tar: "Cortex Helps When Making Decisions"]

[Text]

The Expert System Operates Associatively: "Pattern-Matching" Algorithm

An expe.t system has been developed by the British company Resolution Software. This system overcomes the limits of conventional expert systems and provides a broad range of functions. The expert system, called Cortex, has an inference engine that is based more on association than deduction. This engine takes into account that an area of knowledge can yield more than one valid solution, claims Resolution Software (29 Larkspur Avenue, Nottingham NG5 8JU, United Kingdom, Fa. +44(0)602-20 68 01). Cortex is intended for users who have expert knowledge but are not experienced in programming, it is further claimed. The system is primarily intended for decision support tasks, for example, in the financial sphere, in information situations, and when solving diagnostic problems of all types. The expert system can also determine the structure of every coherent knowledge base, even if this structure is "somewhat confused."

No use was made of the conventional languages of Prolog or Lisp. The knowledge or the information is rendered into logical relationships using a pattern-matching algorithm. The knowledge base consists of a record with up to 1000 questions and another record with up to 1000 solutions. Both are ASCII text files.

Recently added information is detected by the system and automatically taken into consideration. Changing previously entered relationships is not required. Cortex also accepts that users are not acquainted with all aspects of the knowledge area. In addition, the system accepts the answer, "I don't know" to questions posed by the system. In all cases and when a number of solutions are provided, each solution is output with an estimate of its reliability. The DOS program Cortex runs, according to claims, on IBM-compatible computers of the type 286 and later. Windows, OS/2 or a mouse are not needed.

DEFENSE R&D

EU: Defense Industry's Strategic Maneuvering Analyzed

Alliances

94WS0454A Paris L'USINE NOUVELLE in French 14 Jul 94 pp 10-12

[Article by Jean-Francois Jacquier: "Arms Industry: This Is What Alliances Will Change"—first paragraph is L'USINE NOUVELLE introduction]

[Text] **The European military industries can no longer live off their national bases. Prohibitive costs, pressure from the Americans: the trend toward concentration is accelerating. French groups intend to play a central part.**

On 14 July, 600 German, Spanish, Belgian, and Luxembourg soldiers marched down the Champs-Elysees side by side with the French : the European defense forces. A purely symbolic event, considering the many obstacles to integration that still remain.

For its part, the European arms industry can no longer wait. Suffering from excess capacities and often deficits, having run out of state financing, and exposed to American competition, arms manufacturers can no longer bear to just mark time. "To look ahead and make Europe our new domestic market," according to Louis Gallois, the Aerospatiale CEO, is the manufacturers' only way to salvation. Actually, in the United States, where sales are three times larger, the arms industry now consists of only 200 main companies, compared with 750 in Europe.

Based on this observation, the Europeans are taking multiple initiatives. Alliances, acquisitions, cooperation agreements, within a few months the military industries have deliberately chosen a war of movement. In France, whether private or state-owned, major prime contractors are leading this new crusade. And if, recently, the government decided to reappoint Louis Gallois (Aerospatiale), Alain Gomez (Thomson-CSF), and Gerard Renon (SNECMA [National Company for Aircraft Engine Study and Manufacturing]) as CEOs of their respective companies, it was because these men have already made their first moves in the forthcoming large-scale bargaining.

Increasing Number of Rapprochements

On three recent occasions, in quick succession, decisive impetus was given to this concentration movement, which had long been viewed as an unavoidable challenge. First, the announcement that GIAT [Land Weapons Industrial Group] Industries, Panhard, Krauss Maffei, and Mercedez-Benz had formed a joint company to develop a future modular armored vehicle (VBM). A major French-German first in a field where cooperation always aborted. This might be the embryo of a European land-weapons industry. Second, Thomson-CSF's acquisition of the British Thorn-Emi's optronics and electronics activities. This acquisition strengthens the French defense-electronics manufacturer's position as European leader. Finally, the signature, on

Monday 11 July, of an agreement between France, England, and Italy, to launch the European anti-aircraft frigate, the Horizon. This will entail the creation of several industrial consortiums.

Actually, almost every day brings its lot of new rapprochements. "It is the 1995-2000 military programming law that seems to have triggered it all," according to a representative of the General Delegation for Weapons (DGA). This law sent a clear signal to manufacturers: France is no longer in a position to do it all by herself. Its military equipment effort is certainly less affected by the crisis and geostrategic disruptions than that of other allied countries, but the evolution of expenditures will not make it possible to finance in their entirety the large programs that are coming to maturity (Rafale, Leclerc tank, nuclear aircraft carrier, etc.). To finance these, manufacturers are asked to cut costs and increase productivity.

In the future, research and development credits will be reduced. Therefore, their allocation between manufacturing and R&D will change from 70/30 in 1994 to 75/25 in 2000, resulting in a decrease of R&D credits of about 2 billion [French] francs [Fr] per year. In addition, most of the new programs contemplated will have to be completed within a European framework. This is a clear-cut break: it marks the end of the national independence policy. For manufacturers, it signifies increased cooperation with their neighbors.

Sharing development costs is their first motivation. The technological cost of increasingly sophisticated equipment keeps skyrocketing from one generation to the next. From the Mirage 2000 to the Rafale, development costs are said to have increased 130 percent. For tanks, from the AMX-30-B2 to the Leclerc, costs are said to have increased more than tenfold. This is the cost of increasingly systematic use of electronics and advanced technologies. That trend is not about to fade. On the contrary.

The constraints of modern warfare are still more costly. Electronic warfare, stealth, robotics, precision weapons, "intelligent" ammunition, laser, etc. "Today, no European country can go on fostering competition on its own soil in order to meet the new requirements," Jean-Paul Gillyboeuf, director of industrial affairs at the DGA, observed.

Stretching manufacturing series is the other objective of the manufacturers, who saw their production rates unravel as time went by. Actually, skyrocketing R&D costs affected equipment unit costs. Because of limited budgets, domestic orders got progressively smaller. In France, for instance, the air force was reduced in size from 450 to 390 aircraft. Orders for Leclerc tanks might be reduced to 300 or 400 units, instead of the 1,400 initially planned. This deprives manufacturers of any perspective, as deliveries are spread out in annual instalments. Which, in turn, tends to increase costs.

A regrouping on a European scale is now needed to break this infernal circle. Especially considering the raging competition on export markets. East European countries sell off their stocks in exchange for foreign currency. Middle-East countries, France's traditional clients, and Asian countries, the only ones where military expenditures are still growing, are increasingly locked in by the Americans.

The latter are assured of Washington's unfailing political support. Foreign sales are financed 75 percent by the FMS (Foreign Military Sales) fund, an attractive credit system. The Americans have also made a gigantic effort to become more competitive and adjust to the losses experienced on their domestic market. Within two years, in the United States, over $20 billion's worth of defense-sector activities have changed hands. This rapid concentration movement saw the demise of famous names, such as Grumman (which withdrew from the combat aircraft market) or General Dynamics (which withdrew from the aircraft and missiles market); it also resulted in 200,000 layoffs in the State of California alone.

Looking for a New Critical Size

Already handicapped by research budgets and by series three to 10 times smaller than those of their rivals on the other side of the Atlantic, European manufacturers can no longer keep up. Deprived of exports, they, too, run the risk of falling under American domination. The French government, which not so long ago was unconditionally in favor of its 100-percent French label, now recognizes that the situation has become urgent. "It is true that we are all looking for a new critical size," a representative of the Aerospatiale missiles division acknowledged.

Maneuvering will become more intensive. In the missiles sector, which is particularly subject to the pressure of American giants, two new poles should be created by the end of the year. In this sector, Matra Defense and British Aerospace Dynamics are negotiating a merger of their activities. Aerospatiale and German Aerospace (Daimler group) are doing the same. For its part, Thomson-CSF, the pioneer of external growth, especially in Great-Britain, is trying to gain a foothold in Germany and is planning a regrouping with German Aerospace in the ammunition and missile-propulsion sectors. SNECMA is contemplating the creation of a joint structure with Rolls-Royce, to continue studies on the next-generation military jet engine. Dassault Aviation, although it is working with British Aerospace on the post-Rafale era, is the only company without a genuine strategy.

This concentration movement—which should gradually lead to the creation of multinational companies—is bound to result in some casualties. Eventually, Europe will be able to support only one combat-aircraft manufacturer, one engine manufacturer, one radar manufacturer, and perhaps two missile manufacturers. The most difficult task will be to organize the concentration of hundreds of equipment manufacturers and subcontractors who are still working in the wake of major prime contractors. But if Europe manages to do that, it will finally be ready to talk with the United States as equals.

[Box, p 11]

The French Offensive in Europe

1970

Aerospatiale and the German MBB [Messerschmitt-Boelkow-Blohm] (which since then merged into German Aerospace) create the Euromissile Economic Interest Group to produce the Milan antitank and the Roland ground-to-air missiles.

1980

Aerospatiale, German Aerospace and British Aerospace (Great Britain) form the Euromissile Dynamics Group to develop third-generation antitank missiles.

1989

Thomson-CSF (France), Aerospatiale, and Alenia (Italy) cooperate within Eurosam to develop a surface-to-air missile family.

1990

—Matra Marconi Space, the leading European manufacturer of civil and military satellites, is formed by merging the space activities of MATRA [Mechanics, Aviation, and Traction Company] (France) and GEC-Marconi (Great Britain).

—Thomson-CSF acquires the European defense activities of Philips (The Netherlands), and creates a 50-50 joint company with Ferranti to make sonars.

—Thomson-CSF, Thorn-Emi (Great Britain), and Martin Marietta (United States) create the Euro-Art consortium to develop Cobra, the first active-antenna counter-battery radar.

1991

—Aerospatiale and German Aerospace merge their helicopter activities to create Eurocopter.

—Aerospatiale, German Aerospace, Alenia, British Aerospace and CASA [Spanish Aeronautical Engineering Company] create the Euroflag consortium to study a new European military transport aircraft.

—Thomson-CSF create a 50-50 joint company with Pilkington Optronics (Great Britain).

—GIAT Industries takes over the Belgian group FN Herstal and becomes the world's leading small-arms manufacturer.

1992

—Aerospatiale, SNPE [National Powders and Explosives Company] (France), Bayer (Germany), and German Aerospace create a joint missile-propulsion company, Celerg.

—Thomson-CSF acquires 49 percent of SAES (Spain), a company specialized in submarine activities.

1993

—Thomson-CSF and the Irish Short Brothers form a joint venture to develop very-short-range ground-to-air missiles.

—Messier-Bugatti (France), a subsidiary of the SNECMA group, decides to merge its landing-gear activities with the British Dowty.

—GIAT Industries and the Swedish Bofors sign a cooperation agreement to develop and manufacture an "intelligent" shell, the Bonus.

—SNECMA and Rolls-Royce contemplate the creation of a joint structure to continue their studies of the next-generation military jet engine.

1994

—GIAT Industries signs a second cooperation agreement with Bofors, covering a new artillery system. The French land-weapons leader also announces the creation of a joint company with Royal Ordnance (British Aerospace group) to develop telescopic ammunition.

—With Krauss Maffei, Mercedes-Benz (Germany), and Panhard (France), GIAT Industries also creates a consortium to work on the modular armored vehicle project (VBM).

—Thomson-CSF acquires the missile optronics and electronics activities of the British Thorn-Emi and announces the creation of two joint ventures with Deutsche Aerospace, in intelligent ammunition and missile propulsion.

—Launching of the first stage of the French-Italian-British Horizon frigate project that should bring together several European manufacturers including, in France, the Directorate of Shipbuilding (CDN), Thomson, or perhaps Dassault Electronics, and the Signal Company.

Until the End of 1994

—Aerospatiale plans to announce the merger of its missile and satellite activities with those of German Aerospace.

—MATRA is also expected to join British Aerospace in the missile sector.

—Matra Marconi Space might take over the satellite division of British Aerospace.

Missiles: The Overwhelming Superiority of the United States (Ranking of Leading Western Missile Manufacturers)

Manufacturer	Country	Sales (Billions of Dollars)
Hughes	United States	2.75
Raytheon	United States	2.65
McDonnell Douglas	United States	1.2
Thomson-CSF (with Shorts)	France	1.2
MATRA	France	1

Missiles: The Overwhelming Superiority of the United States (Ranking of Leading Western Missile Manufacturers) (Continued)

Manufacturer	Country	Sales (Billions of Dollars)
Aerospatiale	France	0.95
British Aerospace	Great Britain	0.9
Loral	United States	0.75
German Aerospace	Germany	0.6

Source: L'USINE NOUVELLE

A Threatened Business—Evolution of French Exports of Defense Equipment (Billions of Constant 1993 Francs)

Year	Amount	Remarks
1984	84	1 Thakeb contract with Saudi Arabia
1985	57	-
1986	30.7	-
1987	34	-
1988	42.7	-
1989	22	-
1990	36	Effect of Gulf Crisis
1991	35.5	Sale of six frigates to Taiwan (Fr10 billion)
1992	46.6	Sale of 60 Mirage 2000-5 to Taiwan (Fr21 billion)
1993	40	Sale of 400 Leclerc tanks to the Emirates (Fr21 billion)

French manufacturers are caught in a stranglehold by shrinking markets (due to military budget cuts), U.S. competition, and the East European sell-off. The large contracts recently signed with Taiwan cannot offset lost sales in the Middle East, in spite of the breakthrough achieved by GIAT Industries in the Emirates.

Sources: National Assembly; L'USINE NOUVELLE

[Box, p 12]

Seven Measures to Reduce Costs

The DGA (General Delegation for Weapons) has just introduced new rules in order to encourage defense companies to improve their productivity. Objective: a gain of 2 percent per year. This ambition may seem modest, compared with other sectors. Within the military-industrial complex, for which cost accountability was never a priority, this initiative nevertheless amounts to a small revolution. Three measures are proposed for immediate implementation: to freeze for the next three years the hourly rates used to draw up contracts; to revise the prices of the contracts signed by the DGA (in current francs) by no more than 3 percent per year; to declare a moratorium on technical modifications for current programs, as they lead to cost increases.

In the intermediate term, a value analysis of major programs will make it possible to eliminate specifications whose cost is excessive compared with their operational effectiveness. More effective cost control will also be implemented, based on the French General Accounting Office's recent recommendations. Financial and legal expertise specialists will be added to the DGA's contracting departments. Finally, all new contracts, or new instalments of older contracts, will be negotiated on a fixed-price basis.

Eurocopter Case Study

94WS0454B Paris L'USINE NOUVELLE in French 14 Jul 94 p 13

[Article by Jean-Francois Jacquier: "A Close Look at a French-German Alliance: The Many Stages of Eurocopter's Integration"]

[Text] **Jean Bernadet, general manager of Eurocopter France, does not conceal the difficulty of the undertaking: "It will take at least one generation" to complete the integration of the European helicopter manufacturer.**

Created a little over two years ago by the merger of the helicopter activities of Aerospatiale and MBB (taken over by German Aerospace within the Daimler group), Eurocopter still claims to be a "prototype" of future regroupings in the European defense industry.

First Stage: Merging Commercial Forces

On both sides of the Rhine, the coincidence of military needs for a combat helicopter (the Tiger) and a tactical transport aircraft (the NH90) acted as a catalyst. Neither of the two governments could afford to launch such a venture on its own. As for manufacturers, they no longer had any choice: according to experts, by 2000 there will remain only three or four of the world's eight manufacturers operating in this sector.

The first stage of the merger, the easiest, consisted in pooling commercial forces within Eurocopter International. The sales, sales promotion, and marketing teams (160 people, French and German) now juggle indifferently with the products of both lines. To achieve this, however, seminars on German culture had to be organized for the French, and vice versa.

People also had to overcome petty differences. The French, for instance, swore only by their articulated-rotor technology. Conversely, the Germans were all-out supporters of rigid rotors. Today, all recognize the value of each technology, depending on the size of the machine.

To spare political susceptibilities, and for reasons of assets evaluation, setting up the controlling holding (Eurocopter Holding) and management structures (Eurocopter SA) was more complicated. The Germans, whose contribution to the merger was much inferior in many respects, had to be treated tactfully. Once this task was completed, it quickly became apparent that it was possible to set up a single development directorate, so as to plan a joint future. The French development team carried it off. As a counterpart, the piloting of programs was entrusted to the Germans, although each party retains some autonomy for programs already on the market at the time of the merger.

The rationalization of research and production means proved much more difficult. For reasons of sovereignty imposed by the governments, the merger agreement provides that each entity should retain the ability to develop

and manufacture a helicopter on its own. For the new military programs (Tiger and NH90), development and manufacturing tasks must also be strictly shared. "In other words, we do not exchange everything," a DGA representative confided.

Faced with the need to drastically reduce their costs, manufacturers are nevertheless considering the feasibility of single-source expertise poles for certain manufactures requiring large investments, such as blades, dynamic assemblies, composite structures, or cockpit systems. Also in progress: purchase rationalization. Jean-Francois Bigay, the Eurocopter CEO, asked for savings of at least 15 percent. A voluntarist policy that may bring about a first wave of regroupings among suppliers.

Nevertheless, each company retains its own assembly facilities. At Donauwoerth, on the Danube, as at Marignane (Bouches-du-Rhone), Eurocopter is a business without any personnel: for status reasons, the employees refused to accept the European hat and continue to wear that of their original parent company.

[Box, p 13]

A Complex Structure

- The French contribution to the Eurocopter group is by far the largest. However, to preserve an appearance of balance and spare German sensibilities, capital distribution occurs at two levels: that of the holding, and that of Eurocopter SA, the true general-management structure of the group, of which Aerospatiale owns directly 25 percent.
- Issued from the Aerospatiale and MBB helicopter divisions, Eurocopter France and Eurocopter Deutschland are industrial companies responsible for the development, production, and after-sales service of present and future product lines. They each possess two facilities: Marignane and La Courneuve in France; Ottobrunn and Donauwoerth in Germany.
- Eurocopter International is responsible for sales promotion and sales on behalf of the group.
- Eurocopter Participations controls all foreign subsidiaries and interests.

France: Active Antennae Used in New High-Accuracy Battlefield Radar

BR0308144094 Paris ELECTRONIQUE INTERNATIONAL HEBDO in French 30 Jun 94 p 37

[Article by Y.A.: "Gains in Accuracy for Battlefield Radars"]

[Text] Active antennae are appearing on the battlefield. The Cobra (COunter Battery RAdar) has been developed by the Euro-Art consortium, comprising Thomson-CSF,[1] Martin Marietta, Siemens, and Thorn-EMI, as part of a program linking France, Britain, and Germany. COBRA is now the first radar to apply this technology in a mobile terrestrial vehicle for accurate locating of batteries (cannons, mortars, and rocket launchers). The active antenna gives it qualities of accuracy and processing capacity which are significantly superior to those of conventional radar. Its range is 40 km, with locating accuracy of around ten meters, and discriminating capacity enabling it to identify the types of weapons used. It is capable of locating 40 different batteries, in a 270-degree surveillance sector, in less than 2 minutes. All processing is based on real time analysis of the trajectory and the "signature" of the missiles.

Reliable and Immune to Counter-Measures

The active antenna consists of 3000 transmitting-receiving modules, equipped with MMIC GaAs. It also offers benefits in terms of reliability of detection (5 percent losses on modules do not affect the system's overall performance), and great immunity to the effects of electronic countermeasures, thanks to the control of each phase, and the amplitude of each of the transmitting-receiving modules.

At Dassault Electronique, active radar detection finds helicopters through development of a very light alarm sensor (weighing less than 10 kg), capable of advantageously replacing conventional infrared [IR] or ultraviolet [UV] detectors, which give only partial signatures (mainly of the firing) of the attacking missile.[2] This sensor, the radiating power of which remains very low (making it very unobtrusive), gives a real-time indication of the speed, distance, direction, and time until impact of the missile, which it can also identify. It can simultaneously pilot a decoy-launcher. Dassault Electronique, by exploiting the technologies of radio interferometry[3], is also developing a useful load for drones (unmanned airplanes)[4] undertaking battlefield surveillance, together with a mobile station combining interferometry and GPS [Global Positioning System]. This is dedicated to the detection of airplanes, or missiles equipped with terrain-tracking radar, the radiation of which, being very directional and weak, is traditionally very difficult to identify.

Footnotes:

1. Thomson-CSF is responsible within the consortium for the engineering system and the signal processing. It is producing the transmitting-receiving modules, and part of the MMIC GaAs [Microwave Monolithic Integrated Circuit made of gallium arsenide]

2. Infrared sensors, which are difficult to miniaturize, require cryogenic systems frequently leading to false alarms because of excess sensitivity to atmospheric conditions, like UV sensors (reacting to emissions of some powders), which are also unobtrusive and cheap.

3. Radio interferometry is a system for passive detection of radiation emitted by radar. Its accuracy of locating, based on differential phase measurements, is claimed by Dassault to be within a degree, compared with 3 to 5 degrees for conventional high-level gain radars

4. Dassault Electronique has also developed a synthetic aperture radar in band C, which could replace conventional IR and daylight cameras in drones

France: Dassault Studies Technologies for Future Combat Aircraft

94WS0449A Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 11-24 Jul 94 p 14

[Article by Jean-Pierre Casamayou: "Dassault and Post-Rafale Technologies"]

[Text] *The technologies that will be embodied in Rafale's successor could be studied by means of a new demonstrator.*

With the flight testing of the Rafale still under way, Dassault Aviation's design engineers are already working on its successor. But rather than study a plane whose missions are far from defined, their current focus is on defining and developing the technologies that will be used on these new-generation fighters. As in the case of the Rafale-A during the 1980's, these technologies could be developed on a demonstrator that could be flying as early as the turn of the century.

Actually, the company's 1,500 design engineers at Saint-Cloud are concentrating their research efforts on two vital areas: the technologies strictly speaking (stealth, vulnerability, integration of weapons systems,...), and cost containment. "With the skyrocketing of development costs and the diminishment of funding, cost containment has become fundamental," says Yves Thiriet, general director of engineering. "We are aiming for a cost reduction of 30 to 50 percent for the new-generation planes." This calls for numerous simulations with the aide of virtual models of equipment, utilizing the new "synthetic environment" technique launched experimentally by the Americans.

The technique calls for studying the behavior of a complex system and "virtually" finalizing the development of equipment by means of mathematical models before actually building it. If the simulations have been sufficiently validated, a model is thus obtained that is ready to go into production. Moreover, the new concurrent-engineering methodologies using integrated engineering teams, together with tools such as digital modeling ("Elfini") and CAD/CAM (CATIA [Interactive Tridimensional Computer-Aided Design]) software, will also contribute to a shortening of the overall production cycle (development, industrialization, manufacture). And the use of off-the-shelf electronic components, and of network-based distributed systems built around commercially marketed microprocessors (rather than computers produced specifically for military use), will help to further reduce costs.

But it is in the area of technologies that research is most intensive. More than 300 engineers are engaged in the study of what tomorrow's fighter plane will be like. From the standpoint of shapes and aerodynamics, there appear to be some difficulties in achieving changes. "The concept of enhanced versatility that is being sought to incorporate in the design of French planes limits the possibilities of significantly changing their design," says Pierre Bohn, head of advanced-design studies at Dassault. Moreover, the performance of planes is such that it now exceeds the physical limitations of pilots. Thus, the maneuverability of planes is hardly likely to be improved; nor is a "flying wing" design likely to be adopted in France. At most, we may expect to see planes without vertical stabilizers, with dedicated control surfaces on the trailing edges, and vectored-thrust engines.

'Chameleon' Plane

To incorporate these concepts in the planes of the future, Dassault's engineers are resorting to modeling techniques, a domain in which they are regarded as being among the world's most advanced. These techniques involve the use of software that, as in the case of conventional software, makes it possible to integrate the variables relative to the aerodynamics of the plane, but also to factor electromagnetic terms into the simulation so as to automatically deduce the stealth performance of the design.

In addition to external shapes, Dassault concerns itself above all with the insides of the plane and its architecture. According to Dassault's engineers, "smart skin" technology will bring about a true revolution in the design of planes. It will affect the very notion of both the plane's equipment (avionics, radar,...) and of its stealth objectives. The coatings of the plane's structure will consist of "smart materials" (see AIR & COSMOS No. 1441), in which stress gauges will be incorporated initially that will enable determination of the structure's state of fatigue. Subsequently, these coatings will incorporate shaped-beam antennas distributed over the plane's entire surface areas. The plane of the future will thus have complete control of its emissions and reception. It will be able to create a false electromagnetic signature, or communicate with another plane via data transmission. A patrol plane, for example, could illuminate targets, another plane could provide the navigation, while all the others receive the information, maintaining "silence," but can nevertheless address their objectives.

"Smart skins" will be able to improve the future plane's stealth capabilities, by means of coatings based on piezoelectric ceramics that can be commanded to change their color according to the environment into which the plane is flying. These "chameleon" materials will thus be able to change the optical and infrared signatures of the fighter planes of the future. At a still more sophisticated stage, the use of memory-capable materials will make it possible to avoid the use of mobile surfaces for control of the plane. Using bistable materials, a plane's undersurface could be deformed under the effect of an electric current, producing a warping effect on the wing, then return to its initial shape. Thus devoid of mobile surfaces, the future fighter plane's stealth capabilities will be further enhanced.

Another point being diligently studied is that of all computer softwares. The experts deem that the limits of the realizable have now been reached, in terms of volume and operational reliability, which require very lengthy and very costly verification procedures, and that they must now resort to artificial intelligence, fuzzy logic, and the notion of tolerance to malfunction and slow degradation.

France Funds Onboard Expert System Development for Rafale

94WS0449B Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 11-24 Jul 94 p 21

[Article by Jean Dupont: "Electronic Copilot Gets Green Light"]

[Text] *The General Directorate for Armament [DGA] has launched the exploratory development of an onboard expert system, to be operational by 2005, and capable of assisting Rafale pilots in the accomplishment of their missions.*

It is common knowledge around the laboratories and design-study bureaus that onboard information processing facilities, as we conceive of them today, will reach their limits in some 10 years or so, but 20 at most. True, to date, this technique has enabled us to automate most of the basic functions: navigation, steering, control of the plane and its weapons systems, and to a certain extent, the operation of the plane's sensors.

But the conventional digital techniques, which are determinative, are proving incapable of dealing with the uncertain aspects of the mission. These uncertain aspects mark the majority of situations, because the information captured by the sensors is generally incomplete, indeed sometimes incoherent. The solution resorted to today by the designers of planes is to rely entirely on the judgment of the pilot.

The pilot must assimilate the more or less raw information collected from the plane and make the decision he or she deems best under the circumstances.

With the increase in the number of sensors operating in increasingly numerous and interlaced modes, and the growing diversity of jamming techniques, pilots are now having to confront a tsrue combinatorial explosion of operating procedures for using their weapons systems.

Hence the idea of assisting the pilot's reasoning process, of digesting for the pilot the mass of information being fed back from his or her plane. The system must present to the pilot only that information that is pertinent to the immediate phase of the mission. At the very most, the system will be authorized to propose a limited choice of actions, after which it will be asked to evaluate the global consequences of the human decisions being considered. This describes, in broad outline, the concept of the "electronic copilot."

This project, initialized in 1986 by the DGA, aims to introduce systems based on artificial intelligence, aboard fighter planes, by the year 2010. The aim, of course, is not to replace humans in the cockpit by machines. The electronic copilot will in fact be a high-level dialogue function between the pilot and the pilot's machine. But not until the spring of 1994 did the project actually get under way, with the funding of an expioratory development effort based on the Rafale standard version SU2, the version that is to enter service around 2004, and that will be equipped with all radar operating modes, countermeasures, and forward-looking optoelectronics. On the SU2 standard version, moreover, the pilot will also benefit from a new human-factor engineered configuration of the cockpit, based on a helmet-mounted display.

The aim of the exploratory development phase that has just been launched for a duration of three years is to develop a simulation, without a real-time constraint, in which the Rafale SU2's "electronic copilot" will be put through escort and interdiction missions in depth, with low-altitude penetration. Nine expert modules will be developed by an industry team consisting of Dassault Electronique, Matra Defense, Sagem, Sextant Avionique, and Thomson CSF, under the prime-contractorship of Dassault Aviation.

These nine expert modules are grouped under four coherent domains of expertise:

- Aircraft domain, for which three expert modules will perform the functions of evaluation of the state of the plane, and management of the integrity of the plane, and of its systems.

- Tactical domain, whose two modules will be dedicated to the analysis and forecasting of the evolution of the enemy's tactical means, and to the planning of the response in terms of protection and attack.

- Mission domain, whose module will evaluate the external environment, and modify itineraries as a function of the mission's constraints.

- Integration domain, which provides the arbitration and exchanges of information among the six preceding expert modules. This function of coherence is performed by three other expert modules (pilot's behavior, information management, and plans of action).

Once this first stage is completed, the operation of the resulting data processing maquette will be optimized from the standpoint of running it in a real-time environment compatible with the reactions of the pilot. This stage will take two years to complete, after which the electronic copilot will be "installed" in a simulated cockpit at the Flight Testing Center, to be evaluated by its human peers. And finally, work will begin on the installation aspects of such a system in an actual plane.

Completion of this entire design and development phase is targeted for around 2002, at which time a decision is likely to be made to launch the industrial phase of the project.

France: Ministries To Cooperate in Dual-Use Technology Research

BR0808150594 Paris LA TRIBUNE DESFOSSES in French 8 Aug 94 p 3

[Report signed "O.P." and "S.S.": "Civilian and Military Research Funded from Same Budget"]

[Text] A major first for Ministers Fillon and Leotard. The respective research and defense ministers have decided to join forces to optimize research in dual technologies. This means that civilian research with military applications and vice versa will be thrown into the same ring. At the same

time, the Defense Ministry's research budget, which totalled 700 million French francs [Fr] in 1994, should rise to Fr2 billion next year.

A joint working group, including officials from both ministries, will be set up in the fall. They will reflect on how to allocate these credits where civilian and military interests converge: lasers, nuclear technology, materials, etc.

A source close to Francois Fillon explained: "Already more than half of this money has been allocated to bodies such as the (multidisciplined) CNRS [National Center for Scientific Research], the CEA [Atomic Energy Commission], and the CNES [National Center for Space Research]."

At the Defense Ministry, Francois Leotard is satisfied: "We now have a tap to control the flow." In other words, Defense is to retain the right of veto where this Fr2 billion drawn from its equipment budget is concerned. One of Francois Leotard's staff members explained: "The main thing is that this money is allocated to projects and research that directly concern defense. For example, there is the PALEN program for nuclear test simulation, or the megajoule laser which will also be used for this kind of simulation."

The actual procedure to ensure this control could be the counter-signature system, whereby the Defense Ministry and the recipient ministry would both have to initial the budget allocation plan. The thinking behind this process, which would allow defense specialists to block any transfers of funds which in their eyes are not justified, is that such drains on the budget would not upset the smooth application of the 1995-2000 Military Programming Law which Parliament has just adopted. On the contrary, almost all of this Fr2 billion must go on respecting the commitments made by this law.

The Research Ministry is delighted by this decision. Francois Fillon is not the first minister to have argued in favor of this approach. His predecessors pushed for it many times, but without success: Civilian and military researchers guarded their independence too jealously. His acquaintance with strategic issues and defense circles certainly made it easier for Mr. Fillon to initiate talks.

Sweden: Software Tweak Expected to Improve JAS Fighter Stability

BR1008093894 Stockholm DAGENS NYHETER in Swedish 6 Aug 94 p A12

[Article by Thomas Michelsen: "Filter Guarantees JAS's Steering"]

[Text] Saab believes that it has now solved the problem in its JAS aircraft's steering system that led to two crashes, first in Linkoping, and then in Langholmen during last year's Water Festival.

In both cases, the ultimate cause of the crashes was the fact that the aircraft's steering computer and the pilot became out of synch with each other. In both instances, this resulted in the aircraft starting to vibrate so violently that for several seconds it became totally uncontrollable and crashed.

The JAS is designed to be an unstable aircraft. Put simply, it is back-heavy and tries to roll around in flight the whole time. The advantage of this is that the aircraft can start to turn very quickly; the disadvantage is that the whole time it is in the air, the JAS has to be balanced and counterbalanced using the rudder. Moreover, this balancing act is so fast and demanding that only a computer can handle it. In fact, the rudder of the JAS moves constantly and with great speed during flight.

Lagging Behind

So it is the computer that steers the JAS, and which keeps it stable in the atmosphere. However, the pilot still has some influence on the situation, determining the direction in which the aircraft is meant to fly. Both the stabilizing steering computer and the pilot send commands simultaneously to the aircraft's rudder, telling it how to steer the aircraft.

The catastrophes happened when the commands issued by both the pilot and the stabilizing computer became too much for the rudder. If the rudder fails to obey both the pilot and the computer at the same time, then the pilot experiences a situation in which the aircraft does not respond to him and in which it fails to process both sets of commands. In the worst case scenario, the pilot moves the stick backward and forward very fast several times in an attempt to right the aircraft's position in the air. However, in addition, the aircraft constantly lags slightly behind the pilot's commands. That was what happened above the Riddarfjarden last year, a situation which resulted in the aircraft starting to oscillate so badly—for 2.5 seconds—that it crashed.

Good Results

Last winter, Saab's technicians found a way of eliminating this time lag or phase displacement in the steering system. The solution was to damp the electronic signals, bringing them into synch with the slower, mechanical movements of the rudder. It is described as a kind of electronic filter.

So far, laboratory tests using this filter have produced positive results during simulated flight. As from this fall, the filter will be tested in test aircraft in flight, before being fitted into the first production model.

Like so often in this computer age, it is all happening in the computer program. The error in the JAS aircraft was in its program, and its correcting element—the new so-called filter—will also be installed in the steering computer's program. In the aircraft itself nothing will be changed, only in the computer program.

ENERGY, ENVIRONMENT

Germany: BASF Shows New Plastics Depolymerization Recycling Method

94WS0478B Paris L'USINE NOUVELLE in French 21 Jul 94 p 23

[Article by Jean-Michel Meyer: "From Plastics to Oil"—first paragraph is L'USINE NOUVELLE introduction]

[Text] **BASF is depolymerizing used packaging plastics to extract natural gas and oil which are then reutilized in the group's plants. A unit able to process 300,000 tons per year will be built by 1996...**

Germany has won a victory in the crusade it launched in 1990 against used plastic packaging. This time, a technological triumph: chemical reprocessing. In this country where environmental protection is a sacred cause, BASF [Baden Aniline and Soda Factory] is in effect adding an Eleventh Commandment in plastics recycling: "Thou art oil, and to oil thou shalt return."

As everyone knows, plastics are made from black gold. But BASF is the first to reverse the process, "recreating base materials such as oil and natural gas starting from used plastic packaging materials," explains BASF environmental affairs official Herbert Wanjek.

Substantial Savings

For some weeks now, a pilot unit with a processing capacity of 15,000 tons per year has been doing it successfully in Ludwigshafen. The pilot unit cost 40 million German marks [DM] to develop. And BASF plans to build an industrial unit with a capacity of 300,000 tons per year, a project entailing a financial commitment of DM300 million, plus 1 billion French francs [Fr]!

Veba Oel has fallen behind. At its Botrop facility, the German chemical-recycling pioneer vacuum-blends plastics with distillation residues (coal, heavy oils). By contrast, BASF's pilot unit works solely with miscellaneous packaging materials, generally composed of 80-percent polyolefines, 15 percent polyester, and 5 percent PVC [poly-vinyl chloride].

The plastics are first stripped of foreign materials (glass, minerals, or metals), then crushed into granules and compressed. The compressed plastic conglomerates are heated to 300°C and melted.

At this stage, hydrochloric acid escaping from the PVC is captured and reprocessed in the hydrochloric acid production unit. The liquefied plastics are then depolymerized at 400-500°C.

Depending on the characteristics of the original mix, the process can yield 20 to 30 percent natural gas and 60-70 percent hydrocarbons. The latter are distilled and transformed into naphtha, olefines, aromatics, and diverse heavy oils. "All these products can be utilized like other raw materials in our integrated plants, for example in the steam cracking plant or the gas synthesis unit, to obtain base materials for plastics fabrication," Wanjek explains.

Advantages: The energy economics look good to BASF. Less than 10 percent of the plastics suffice to fuel the process. And material yield is higher than 90 percent. Moreover, triage and stripping of waste are unnecessary. Hence the process offers substantial savings over ordinary materials' recycling. The latter costs about DM3,000 (about Fr10,200) per ton of plastic. And 80 percent of the cost is in collection, separation, and triage! The BASF environmental official notes, however, that "the total cost of chemical reutilization is never covered by the value of the products obtained." Between now and 1996, the BASF process must be subsidized to the tune of DM325 (Fr1,100) per ton.

Albrecht Eckell, a member of the board of directors, predicts optimistically that "by 1998 the problem of reusing plastic materials will be solved." But projections indicate that by 1996 Germany will have an annual reprocessing capacity of 500,000 tons by chemical means and 250,000 by materials recycling. Not enough. This country, which produces 2 million tons of used plastic packaging per pear, will still be wrestling with the same intractable problems. More than half the plastic debris will end up in waste dumps, or headed for Asia.

France: Fluidized Bed Combustion Waste Incineration System

94WS0453B Paris L'USINE NOUVELLE in French 14 Jul 94 p 34

[Article by Jean-Michel Meyer: "Fluidized Bed For Burning Household Waste; introductory paragraph in boldface as published]

[Text] **The Mantes District (in Yvelines) has chosen the fluidized bed system for incinerating its household waste. The method in question results in a lower rate of unburned residue and limits the discharge of gases. This marks one of its first applications to household refuse.**

Air and sand. The Mantes Urban District (DUM) in Yvelines is counting on those two natural elements to incinerate the 80,000 metric tons of household waste produced every year by its 220,000 residents! The method it will use? The fluidized bed. The District Council chose that technology on 20 June for its future energy development center, the startup of which is planned for 1997.

Widely used in Europe and Japan, the fluidized bed is making one of its first appearances in France as a system for incinerating household refuse. The crushed waste is fed into a furnace, where it comes in contact with sand that has been heated to 850°C. Air is injected to mix the refuse and sand together, thus ensuring even combustion of the refuse. The facility planned for Yvelines represents an investment of 285 million French francs [Fr]. It comprises three furnaces, each capable of burning four metric tons per hour, thus bringing the incineration capacity to 90,000 metric tons per year. A center for sorting 5,000 metric tons of household packaging materials per year completes the facility.

It all began at the end of 1993. In September, the DUM issued a call for bids from firms with a view to awarding a public service contract. And selected four candidates. Cofreth (Lyons Water Company), Clinergie (French Electric Company), and Itisa Vollund, a group headed by a Danish grate manufacturer, submitted a traditional solution: a furnace with an incinerating grate. But Valene, a group consisting of two subsidiaries of the General Water Company—the General Heating Company and Sarp Industries—stood out by suggesting a fluidized bed furnace. It was an original suggestion that paid off.

The method is more constraining, however: it requires that the refuse be sorted and crushed before incineration. Out of each metric ton of household refuse, 890 kilograms are incinerated. Upstream from the furnace, an electromagnet removes metals. And a process involving eddy currents removes nonferrous metals. A ventilation process then separates the heavy products from the light products. The former (stones and so on) are crushed even smaller. They are then injected into the furnace, where they compensate for sand losses in the fluidized bed. Waste is incinerated at a temperature of 850°C for two seconds. A boiler fueled by the furnace produces steam that is sent to a turboalternator for the production of electricity that will be sold to the French Electric Company: 15.9 million kilowatt-hours in 1997. And 16.8 million in 1999.

The result? "Thanks to sorting, the rate of unburned waste is reduced from an average of 5 percent using an incinerating grate to 0.5 percent," says the DUM. And it adds: "This method, which is better aerated and more refined than an open-grate furnace, also makes it possible to limit the discharge of gases." And those advantages are obtained at no extra cost.

Total Capacity To Be 130,000 Metric Tons Per Year

Without subsidies, the cost of treatment will be from Fr390 to Fr490 francs per metric ton. But additional guarantees were provided in anticipation of the stricter rules on incineration discharges that are scheduled to take effect in 1996. The discharge thresholds, established on the basis of a survey of the standards in effect in European countries, are more drastic than those imposed in 1991. The traditional treatment of smoke (bag filters, washing of basic and acid gases, and so on) is being supplemented by an activated charcoal treatment that traps dioxins and furans. And the smoke is reheated to eliminate the plume.

The dossiers on building permits and public studies will be filed early in September. Work will begin during the first quarter of 1995 in some old French Cement Company quarries in the commune of Guerville. The layout of the site already includes room for a fourth furnace, which will bring the total capacity to 130,000 metric tons per year, and for expansion of the sorting center to handle 10,000 metric tons per year. In the future, a center for sorting bulky refuse (used refrigerators and so on) and another one for ordinary industrial refuse will also be added.

Located between Highway A13 and Departmental Road 113, the operation will be discreet. The holes left in the cliff overlooking the Seine River by the previous owner will provide it with a refuge.

Two Competing Methods

The horizontal fluidized bed is making its mark in the treatment of household waste. For its part, ABT France, a subsidiary of Germany's Hoelter ABT, signed an agreement with Serete Industries at the end of 1993 to introduce the rotating fluidized bed into France: air injected into the base of the V-shaped incinerator imparts a double rotating movement to the sand. The turbulence thus created homogenizes the refuse and the sand, leaving only 1 percent of the refuse unburned. Invented in Japan, this technology makes it possible to incinerate solid and liquid waste simultaneously. Gien in Loiret plans to equip its incinerator—scheduled for 1996—with that technology.

FACTORY AUTOMATION, ROBOTICS

Germany-Japan: Robot System to Operate in 10-Nanometer Range

94WS0465A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 18 Jul 94 p 8

[Article by oel: "Machining Operations in the Nanometer Range"]

[Text] Engineers at the Research Center for Science and Technology, together with colleagues at the University of Tokyo, have developed a robot system that permits operation in the range of about 10 nanometers. The system was assembled as an experiment. It was capable of "writing" Chinese characters in a matrix consisting of 29 points merely 10 nanometers apart.

Such etching and scoring work, done in the nanometer range, is monitored by means of a scanning electron microscope with a magnification factor of 20,000 and a real-time image control system.

The extremely precise movements are performed by two computer-controlled gripping fingers. One gripper holds the object to be machined while the second does the scoring in the writing test using a very fine tungsten stylus. Both grippers can be moved in all three axes of space. So that there are no magnetic field disturbances of the electron microscope, the movements are performed using piezoelectric, instead of electromagnetic, actuators.

The system may be used to eliminate or repair defects and incorrect connections in large-scale integrated electronic circuits. According to the developers from the Research Center for Advanced Science and Technology (Faculty of Engineering, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan), the system is to contribute to reducing the reject rates in the production of electronic circuits.

LASERS, SENSORS, OPTICS

Polymers Used for Displays, Switches

94WS0468A Duesseldorf VDI NACHRICHTEN in German No. 28, 15 Jul 94 p 10

[Article by Richard Sietmann: "Polymers Glow and Switch"; Subhead: "Electronic Materials: Semiconductor Plastics Grow Increasingly More Interesting for Electronics"]

[Text] *Berlin, 15 July 1994—Semiconductors are the basic material for electronics and their performance can be specifically determined by tinkering with the crystal structure. Until now they have been almost exclusively crystalline,*

inorganic materials such as silicon, for example. Currently, polymer materials are growing increasingly more interesting for electronics.

Alongside traditional semiconductor materials in micro- and optoelectronics, polymers often play an unrecognized role. Although the chip production process is inconceivable without them, for instance, as photoresists in lithography, they also are the underlying material of the printed circuit boards on which the components are located and they are the material of which the chip casings are made. But in the opinion of professor Gerhard Wegner, director of the Max Planck Institute for Polymer Research in Mainz, "this is a passive role." This may also be why intensive research in the field of polymer electronic materials has so far been "not so awfully spectacular."

Lately, however, this picture has changed. It is increasingly shifting to an active role from the passive one of underlying and insulating material. In 1990, Frenchmen Francis Garnier and Denis Fichous of the CNRS [National Scientific Research Center] Molecular Materials Laboratory in Thiais, were the first to successfully develop a polymer transistor from organic semiconductors. In the same year, Richard Friend of Cambridge University's Cavendish Laboratory demonstrated with PPV (polyparaphenylene vinylene) plastic the close affinity, even in the case of optoelectronic properties, of organic and crystalline semiconductors. He showed that PPV light diodes emit a yellowish-green light at an applied voltage of a few volts.

Solid-state physicist Guenther Leising and his team at the Technological University (TU) of Graz even managed to produce a polymer light diode that emits the prized blue light, albeit for only a few seconds. On top of that, Bayreuth University's professor Markus Schwoerer opines: "The useful life is a humongous problem." In any event, his polymer diodes have now glowed for nearly four weeks, albeit after that time the emission has dropped to a hundredth of its original intensity. Although the intrinsic efficiencies of nearly one percent for the conversion of current into light—the so-called quantum yield—can fairly compete with those of inorganic light diodes, the 10^5 -hours serviceable lifetime of conventional LEDs [light-emitting diodes] available on the market still needs to be matched by the their polymer rivals.

Many scientists view the distinctive nonlinear optical (NLO) properties of some plastics as more significant than the active components where polymers merely mimic what inorganic semiconductors have been able to do better now for a long time. Optical nonlinearities always surface if the refractive index is not constant during the throughput of a light source through the material, but instead fluctuate under the impact of electrical fields. Wagner opines: "There are quite intensive efforts worldwide in research on polymer-based electro-optics."

There are many reasons for this. Compared with inorganic, crystalline electro-optical materials, NLO polymers hold considerable potential for ultrafast optical switches with limited loss of power. Joseph Zyss, head of the molecular quantum electronics section of France Telecom's CNET [National Center for Telecommunications Studies] and a veteran pioneer in the field of organic NLO materials, for example, projects: "Four hundred gigabits per second should be no problem."

Until now electro-optical switches, whose refractive index has to display high responsiveness to applied electrical fields, have been manufactured mostly of lithium niobite crystal and that material is non-integrable; it is bulky, requires high gate voltages and is expensive. Whereas inorganic materials need dimensions of several centimeters, organic crystals get by with less than two millimeters [mm].

Furthermore, their processing is less costly and bodes to be cost-effective in mass production. And they are compatible both with III/V semiconductors for optoelectronics and with the silicon for microelectronics. Zyss emphasizes: "Polymers can be easily worked into thin films via precipitation or spin-coating. We have now developed a compatible polymer/semiconductor technology that can be integrated in the established production process with slight adjustments."

The CNET has now licensed the patent-protected production processes for NPP and POM [polyoxymethylene] to the "quartz and silicon" subsidiary of the Saint-Gobin chemical company that specializes in the manufacture of electronic materials.

With gate voltages of nearly eight volts, the CNET scientists are already quite close to the operating voltages of silicon circuits. Zyss explains: "We now expect shortly to break through the five-volt threshold and pull abreast of silicon." He and his team are also engaged in improving the thermal stability of the two NLO polymers.

CNET's ultrafast electro-optical switches are targeting the time multiplex stages of optical switching centers where, in the future, for optical asynchronous transfer mode (OATM), the issue will be selecting individual data packets from a bit stream and rerouting them. Although no additional change in electronic signals will be required for that process, those system nodes are still characterized as optically transparent. Additionally, however, they also require for the time stage a transparent space stage in which the signal arriving in an input fiber can be fully switched to a specific output fiber.

Scientists from Berlin's Heinrich Hertz Institute (HHI) have now integrated on a 30-mm by 1.7-mm-sized polymer chip a (4x4)space-switch matrix whereby four inputs can be randomly switched to four outputs. Its function depends on the thermo-optical effect: tiny heat electrodes warm up one of two closely adjacent wave guides locally changing the refractive index and thereby causing the signal to cross over from one wave guide to the other.

Unlike the ultrafast electro-optical switches having switching times in the pico-second range, thermo-optical NLO polymers need nearly one millisecond per switching process; however, that suffices without any problem for the systems requirements in the space stage. And the serviceable lifetimes—research is still underway at HHI on this—seem to be less critical than in the case of electro-optical polymers.

UK: Mass Spectrometer on Single Chip to Be Developed

94WS0457D Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 14 Jul 94 p 8

[Article by "oel": "Mass Spectrometer on a Single Chip. British Company Working With Microstructure Process"]

[Text] Frankfurt—The British company Applied Microengineering in Bourne End has begun development work on making a miniature mass spectrometer that contains all the necessary components on a single chip. The device, which is to be marketable in about three years, will be used first of all in environmental protection for the rapid analysis of gases, the company hopes.

Mass spectrometers are used to analyze and thereby precisely determine atoms, molecules or ions, as the case may be, from the character of their mass and charge. The particles are charged and accelerated in electric and magnetic fields, whereupon the various particles also travel variously long distances according to their mass and charge, and then they can be clearly distinguished according to their order.

The spectrometer's basic design is protected by a patent. It is to be manufactured by micromechanical working technologies in cooperation with two or three other British companies. The company is hoping that the European Commission will contribute to the relatively high development costs within the framework of the Framework-iV program.

In the working technology employed here, detectors will record the measurement results and a computer will interpret the spectroscopic data. Of course, a miniature instrument will not be able to attain the high precision of the mass spectrometers used to date. But according to predeterminations available to date and several experimental circuits, according to the reports, gas analyses can be obtained that are sufficiently precise to identify very quickly and on the spot specific noxious gases important from the viewpoint of environmental protection.

Moreover, the company plans to develop a gas chromatograph that is also to be made with micromechanics. Applied Microengineering, Ltd. (Bourne End, Bucks SL8 5AS, United Kingdom) reports that it is also to be used in environmental protection and is to supplement the mass spectrometer's measurement results, for with it sufficiently precise quantitative and qualitative analyses can be made of gases or substances that can be gasified.

MICROELECTRONICS

Germany: SGS-Thomson Seeks Increased Share of Microelectronics Market by Year 2000

94WS0457C Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 13 Jul 94 p 8

[Article by "re": "Microelectronics Experiencing Rapid Further Growth. Global Market Volume of $200 Billion Expected by Year 2000"]

[Text] Frankfurt—Market researchers at the SGS-Thomson Microelectronics GmbH [Limited Liability Company] company in Grasbrunn estimate that the global market volume for semiconductors can grow to $100 billion by the year 1995. Sales volume will double to around $200 billion by the year 2000. Fifty billion dollars' worth of semiconductors were sold in the year 1990.

The demand for semiconductors has grown by 15.5 percent on average per year in the past 30 years. Now, however, a certain leveling off to 13.5-percent average growth per year is estimated. Moreover, the market will have matured by the end of the decade, so that then it will be comparable with other major markets like steel, for example. SGS-Thomson Microelectronics observes that the industry is like other branches of industry, in that concentration grows the more mature the industry becomes and the more the cost of the development and manufacture of new products grows.

As the company points out further, semiconductor technologies are the driving force of the electronics industry, which, with estimated world sales of $700 billion in the current year, is already reaching the same volume as the automobile industry. Though semiconductors themselves are only approximately 10 percent of the total cost of electronic equipment, the performance of these products depends totally on semiconductor technologies. Continuous innovations and cost-cutting in the semiconductor industry are thus the guarantee of growth in the electronics market.

The global market volume for semiconductors is estimated at $77 billion for the past year. The United States had a 32-percent share, followed by Japan with 31 percent, Europe with 19 percent and Asia with 18 percent. SGS-Thomson Microelectronics illustrates that, broken down by product families, microprocessors, microcontrollers and peripherals accounted for 25 percent, memory chips for 28 percent, special-purpose circuits for 18 percent and discrete and optoelectronic semiconductors for 15 percent.

The non-specialized mass markets are being supplied by more than 100 semiconductor manufacturers over the entire world, and the largest 20 manufacturers have a combined market share of 75 percent. SGS-Thomson Microelectronics reckoned it was in 13th place among the leading semiconductor suppliers in the year 1993.

The 20 largest in the industry are "broad-spectrum" manufacturers that cover practically the entire product range. For the smaller companies outside the leader group it is a question of either specialized manufacturers or niche suppliers. The 10 largest semiconductor manufacturers could cover around 60 percent of the demand in the year 2000, while their share at present comes to only 55 percent. Moreover, SGS-Thomson Microelectronics is aspiring to rise into the group of the 10 largest companies in the industry.

Germany: Siemens Puts Sender-Receiver Elements on One Chip

BR1708120094 Berlin DIE WELT in German 3 Aug 94 p 7

[Unattributed report: "Inner Life of a Handy on just one Chip"]

[Text] Munich—Siemens researchers have succeeded in combining on a single silicon chip all the elements, excepting the antenna, needed for transmitting and receiving in the Gigahertz range. This would make it possible to construct hand instruments for mobile radiocommunications with only two chips. They currently comprise several hundred components installed in an area of approximately 10 to 20 square centimetres. The advantages of the new chip are smaller volume, lower power consumption, and reduced manufacturing costs.

Germans, Japanese in Project To Develop 16-Inch Wafer

94WS0483A Bonn DIE WELT in German 2 Aug 94 p 11

[Article by Christoph Hein: "MITI Cooperates With Germans"]

[Text] Berlin—It is the first time an extensive development project has been planned between two German and four Japanese chemical companies, as well as the Japanese Ministry for International Trade and Industry (MITI): U.S. Huels AG (Veba) subsidiary MEMC, St. Louis, and 50 percent Hoechst-owned Wacker-Chemie GmbH, Munich, received an offer from the leading Japanese silicon producers (see table) to begin the development of new wafers as early as this year. These are disks of pure silicon, the raw material for computer chips. The new wafers are to have a diameter of 400 millimeters; so far 200 millimeters is usual and 300-millimeter disks are being tested. In the future, chips could then have a storage capacity of a billion bits and the waste during manufacture would be reduced. As a reason for this unusual cooperation, the level of German research and the high development costs are mentioned. Another reason why the Japanese have approached the Germans for the first time would be more interesting to the cartel authorities: The participants can be assured of reaching the market with the new technology at the same time. The research costs are to be distributed according to the size of the companies. In so doing, there are no thoughts of a common research center: "Defined tasks will be distributed to the participants and solved there," explains Werner Duismann, controller for the silicon division at Huels.

The consumers could be all the manufacturers of hardware, among them Siemens, IBM, Intel and Motorola. The new product will be expensive even for them, because the users down the line have to equip their production lines with new machinery. There is a "boom market" for wafers. After a 1993 volume of 2 billion U.S. dollars, world sales of about 2.4 billion dollars are already anticipated for this year.

Raw Material for Computers; World Market for Silicon Wafers in Microelectronics (Total: 2 billion dollars) (Information for 1993 in percent)

Shin-Etsu	27
MEMC (Huels AG/Veba)	20
Osaka Titanium Corporation	13
Mitsubishi	12
Komatsu	10
Wacker-Chemie GmbH (Hoechst AG)	9
others	9

Italy: Synchroton Company Forms Alliance with Micromachine Firm

MI1808141994 Milan IL SOLE-24 ORE in Italian 20 Jul 94 p 11

[Article by Elena Ragusin: "Trieste, the Synchrotron Company Forms Alliances with Small Enterprises"]

[Text] Trieste. A few months after its first laboratories entered into operation, the synchrotron light machine in Trieste is opening its doors to private industry. Yesterday, Giuseppe Viani, the managing director of the company that manages the scientific facility in Trieste, announced the signing of a contract for the development of an X-ray light line with Micromore. Micromore, a newly established Trieste-based company, develops micro components using an advanced technique called LIGA (Lithography and Galvanometry).

Thanks to the use of the synchrotron light during the study and design phase, Micromore will be able to produce micro components such as sensors, connectors, and deviators for optical fibers, micro filters, and components for biomedical equipment.

According to Nobel Prize Laureate Carlo Rubbia who presides over the Synchrotron Trieste company, within a few years LIGA technology "will lead to the production of mechanical objects measuring less than a thousandth of a millimeter, and this will revolutionize our daily lives and the structure of the economy itself. For example, we will be able to build "micro robots" in the medical field which, once inserted into the veins of patients, will be capable of identifying and eliminating any danger of arrest in the circulatory system. Another sector where this technology can be applied is sensors. It will be possible to develop highly extended networks to monitor pollution and also to obtain great energy savings through the use of combustion processes.

The investment envisaged for the development of the ninth synchrotron light line, which will enter into operation within a year (other lines have already been commissioned from Synchrotron by leading public companies such as ENI [National Hydrocarbons Corporation] Research and ENEA [National Agency for New Technologies, Energy, and the Environment], is estimated to be 1.3 billion lire. Within the next five years, Micromore foresees investing more than 20 billion lire overall, part of which will be allocated for the development of a very high technology production facility to be established in the vicinity of the light facility.

"Our field of action," Micromore President Bruno Gasparetti explained yesterday in a press conference, "represents one of the most advanced frontiers of high technology, an

area where research institutes and industries from the most industrialized countries in the world are confronting themselves." Currently only three European groups in France and in Germany are working in this field and also using synchrotron light. The Trieste scientific facility however, offers further development opportunities in chip research and development for micro components, thanks to the extremely advanced characteristics of its light lines.

The investment made by Micromore has been evaluated by Carlo Rubbia as being "the best response to the technological challenge from the United States and Japan, a response that disproves the myth of Trieste being an aged and economically passive city."

According to the managing director of Synchrotron, the initiative by the Micromore company, controlled by a group of businessmen from the Friuli-Venezia Giulia region, demonstrates "that the light machine is not accessible only to large groups or public companies. We are open to all companies that intend focusing on applied research. The relatively low investment for the development of the new Micromore light line, a little over 1 billion lire, clearly indicates that Trieste is capable of offering an instrument of scientific excellence to a very wide range of businesses."

Italy: High-Speed Cryptochip Developed

MI1808142994 Milan IL SOLE-24 ORE in Italian 29 Jul 94 p 18

[Article by Marinella Zetti: "Amtec Launches the Inviolable Chip"]

[Text] The cryptochip that Amtec has perfected in collaboration with the Bordoni foundation, and has produced using 0.5 micron NEC technology, is called RSA 512. According to Gianfranco Bagella, founder and president of Amtec: "The chip is three times faster than the products that are currently available. Its computing power is four times that of a 386 microprocessor and it is possibly the most complex ever developed in Italy."

However, before talking about the chip and its applications, let us try to get to know Amtec. The company was established using private Italian capital in 1980, and it designs, produces, and distributes telecommunications systems for data transmission, as well as developing and distributing software applications, and providing maintenance and training services.

"We do not want to be leaders," says Bagella. "We just follow the market and try to understand the requirements of the user. In other words we are a link between the producers of technology and the users."

Amtec's head office, production unit, administrative, and technical management offices are located at Piancastagnaio in the province of Siena. However the general management, the commercial management, and the commercial organization for central and southern Italy are in Rome, and the commercial management for northern Italy is in Milan.

Amtec has a total of 60 employees, 70 percent of whom are university graduates in mathematics, engineering, electronics, or computer science. Forty people work at Piancastagnaio and 20 are employed in the Rome and Milan branch offices.

"The decision to set up the company in Piancastagnaio was not taken by chance," emphasized Bagella. "We chose a location that was in central Italy, halfway between Milan and Rome, but above the Southern Italy Development Fund area. Furthermore, having the head office in that location can avoid the staff turnover that enriches Silicon Valley, but that would only be a loss for a company like ours."

Amtec's principal clients include Cariplo, Credito Italiano, Cedacrinord, Sia, Italsiel, the prime minister's office, the supreme court of cassation, the state finance department, and various ministries.

Over the last four years Amtec has registered a 40-percent growth rate with revenues of around 10 to 12 billion lire. "In 1993," specified Bagella, "we invested 16 percent of our revenues in research and development. This percentage is higher than that of the most important multinational companies operating in the sector. Furthermore, a total quality program was set up in all the sectors of the company in 1993, and this should shortly lead to ISO 9001 certification."

The RSA 512 was created as a result of these investments. "The innovative characteristic of the product," explains Bagella, "consists in the use of a custom chip to calculate the RSA public key encryption algorithm. The system contains a register with an external floating battery for the memorization of the private key. Any attempt to violate the chip and gain access to the private key leads to the destruction of all the data it contains. The cryptographic application works over the entire network, from user to user, and the security functions operate at level 3 of the OSI (x 25).

The RSA 512 cryptochip will be ready for delivery in November but already met with noteworthy success at the annual exhibition of military electronics and communications equipment last May. Amtec's short- and medium-term development strategies provide for new products and services in the security area, OSI CGM standards, client-server applications in a management environment, advanced high-speed routers, and successively, frame relays, FDDIs [Fiber Distributed Data Interface], and ATMs [Asynchronous Transfer Mode].

NUCLEAR R&D

German Research Minister Breaks Ground for BESSY II

BR1808083794 Berlin DIE WELT in German 5 Jul 94 p 9

[Article by Norbert Lossau: "Construction of Super X-Ray Source Started in Berlin"]

[Text] Berlin—Federal Research Minister Paul Krueger symbolically broke ground yesterday at the research and

technology park in Berlin-Adlershof for the construction of the new electron synchrotron Bessy II. This will be the first large-size instrument of basic research in the natural sciences to be erected in the new Laender. The construction costs of roughly 195 million German marks [DM] will be paid in equal parts by the Land of Berlin and the Federal Ministry for Research and Technology (BMFT). The decision for the construction of Bessy II had been made in July 1992 by previous Research Minister Heinz Riesenhuber, after years of struggling between the Land of Berlin and the BMFT. The new research facility is expected to be ready for use by scientists in 1998.

In the round accelerator of Bessy II electrons will be racing in a circle of 240 meters at nearly the speed of light, emitting a so-called synchrotron radiation. In the case of Bessy II that radiation will be in the soft X-ray region. The generated X-rays will be extremely concentrated and of great intensity. The use of special magnets forcing the electrons to oscillate in their path will increase the radiation intensity in Bessy II to 10,000 times the level of the synchrotron Bessy I that has been in operation in Berlin-Wilmersdorf since the beginning of the eighties. The X-ray radiation generated by Bessy II opens completely new experimental possibilities. It will allow the operation of a high-resolution X-ray microscope with which even details of human chromosomes can be examined. The synchrotron radiation is of special importance for the production of highly integrated semiconductor chips and components for microstructure technology. The short wavelength of X-rays allows the illumination of smaller areas than would be possible with visible or ultraviolet light.

Bessy II is primarily an instrument of basic research from which physicists, chemists, biologists and material researchers will profit. In addition the operators of Bessy II are also hoping for an interest on the part of industry. One quarter of the annual operating costs of approximately DM40 million are planned to be brought in through user fees.

France: CEA Safety Inspectorate Issues Report on Cadarache Accident

94WS0477C Paris AFP SCIENCES in French 21 Jul 94 p 15

[Article: "Cadarache Accident: 'Unstoppable,' According to Experts"]

[Text] Paris—The accident at one of the installations of the Cadarache Study Center (Bouches-du-Rhone) last 31 March was "unstoppable," according to Chief Inspector Francois Cogne of the CEA [Atomic Energy Commission] Nuclear Safety Department, who is responsible for the internal investigation conducted by CEA Chief Administrator Philippe Rouvillois.

Occurring in a Rapsodie fast breeder (shut down since October 1982) at a subsidiary installation while specialists were trying to reduce a pool of sodium in an 8-meter-long tank, in this accident one person died and four were injured. After an investigation lasting three and a half months, Mr. Cogne's report, running to 70 pages about 140 pages of appendices, a summary of which was published on 19 July, confirms the fact that the accident was the result of a chemical reaction that got out of control.

"The chief cause of the accident was the formation of a complex, heterogeneous, multiphase physicochemical environment composed of the alcohol, alcoholate, and sodium present in the tank, which, under the effect of the heat that was produced, resulted in the formation of 300 m^3 of hydrogen, ethylene, and hydrocarbons in a little over an hour, which was not discovered in time. The whole process ended in the tank's rupturing and causing an explosion," Mr. Cogne explained to AFP. While the chief cause of the accident is known, "we don't know the exact chemical reaction that was produced on the day of the accident, eight days after the start of operations, and which got out of control."

"Begun on 24 March, the process of cleaning the alcohol out of the tank was interrupted during the weekend, during which time a crust of alcoholate and paste-like sodium formed in the tank," Mr. Cogne indicated. "The operations were resumed on Monday with new injections of alcohol. Thermal and catalytic decomposition reactions releasing a lot of heat occurred and the whole process resulted in a rise in the temperature of the very heterogeneous environment in this long tank to over 300°C without the rise in temperature's being noticed."

The CEA communique on the report specifies that "the state of our knowledge didn't permit us to foresee or anticipate that these chemical reactions would get out of hand," all the more so since "the technique used was well known and accepted by everyone, in France as well as abroad, and since it had been well mastered at the CEA." It had been used without any problems before 1986 and for the destruction of 37 tons of primary sodium from the Rapsodie at the beginning of this year.

As a result, new studies and expert evaluations are to be conducted between now and the end of the year under the direction of a project chief. Between now and their completion, the cleaning process employed at the time of these operations for the dismantling of Rapsodie will no longer be used by the CEA.

Moreover, "greater vigilance" will be brought to bear on:

- the design of installations involving dangerous products with the aim of facilitating their dismantling,

- the conditions for retaining part of operational teams after the final shutdown of an installation,

- the use of solvents, particularly the study of the derivatives obtained and of the mixtures thus constituted.

France: Superphenix Fast Breeder Seen as Yet Unfit for Research

94WS0477D Paris AFP SCIENCES in French 21 Jul 94 p 16

[Article: "Superphenix Fast Breeder Cannot Be a Research Reactor Before the Year 2000, According to GSIEN"]

[Text] Paris—The Superphenix fast breeder cannot be a research reactor before the year 2000, the Organization of Scientists for Information on Nuclear Energy (GSIEN) asserted on 13 July, the day following the publication of the interministerial order authorizing the restarting of the reactor.

This decision, the GSIEN (an independent organization founded in 1975) maintains, "thumbs its nose at the reservations voiced by the DSIN (Directorate of Nuclear installation Safety), a safety agency and therefore responsible for this safety. The conjuring trick consisting of declaring that this prototype reactor is for research and demonstration would be the epitome of black humor were it not for the fact that this is a reactor that poses serious shortcomings as concerns safety and therefore the safety of populations: from the failure to control sodium fires to the many incidents it has been the focus of. Superphenix is a costly, dangerous, and badly designed machine."

For the GSIEN, this order authorizing it is "a hoax because Superphenix is going to be restarted with its original load to attempt to deliver kilowatt hours and it will therefore not be a research reactor before the year 2000, unless it is shut down before then because of a serious failure."

The GSIEN wonders what has become of the "overtures with an eye to multipartite expertise (for Superphenix) and the reservations expressed by the Environment Ministry," the cosignatory of the order. "Superphenix, whose design goes back to the 1970s, is a technological failure. This fast breeder ought to be shut down and dismantled as quickly as possible. One must know how to discontinue failed experiments and the government would be respected for doing so."

According to the terms of the order published on 12 July, the fast breeder will no longer be a plant for the production of electric power, but a research and demonstration reactor of the fast neutron reactor type. It is also supposed to be used to burn the plutonium produced in nuclear power plants and long-term radioactive waste.

France: Superphenix Fast Breeder Reactor Restarted

BR0508135094 Paris LIBERATION in French 5 Aug 94 p 20

[Report by "V.S." in Creys-Malville: "Superphenix Fast Breeder Reactor Resumed Operation Yesterday at Noon"]

[Text] After four years of inactivity, the Superphenix fast breeder reactor based in Creys-Malville (Isere) was reactivated yesterday [4 August] at 1219 [1019 GMT]. According to a spokesman from NERSA [European Fast-Breeder Nuclear Station] (the company that operates Superphenix), "Everything went fine." Plant management wasted no time, since it restarted the reactor only 24 hours after the government gave its consent.

Such swift action took Superphenix opponents somewhat by surprise. Yesterday, the "Europeans Against Superphenix" association announced its decision to file an appeal with the Council of State. But no demonstration is scheduled for the time being. As for the Swiss, however, a symbolic demonstration will take place at 1400 [1200 GMT] in Annemasse (Haute-Savoie), a city facing Geneva across the border. Activists from the Swiss Contratom association intend to cross the border to visit the nearest French police station and lodge "individual complaints to protest this threat on our lives."

TELECOMMUNICATIONS

New Pan-European EUREKA Project on Digital High-Definition Television

BR0508092894 Hilversum TELECOM BRIEF/ TELEMATICA TRENDS in Dutch 24 Jun 94 p 183

[Unattributed article: "ADTT Is the European Successor to Analog HDTV"]

[Text] EUREKA [European Research Coordination Agency] is supporting a new project for the development of High Definition Television [HDTV]. Among those working on the Advanced Digital Television Technology (ADTT) are Philips and the Netherlands Ministry of Economic Affairs, in addition to the French company Thomson, and Nokia from Finland. ADTT is being seen as the successor to the development of HDTV, which has proved to be a failure.

The partners are hoping, however, that 80 percent of the technology developed for HDTV can still be utilized. ADTT is to produce prototypes for digital transmission of video signals. These will not be for a public broadcasting service, such as HDTV was intended for, but for video applications for home use (multimedia), and for public installations such as are used in hospitals. The system will link up precisely with the system developed in the United States for digital HDTV. It is based on a standard four times sharper than the one we are currently used to, that is to say 1,250 lines, with a 50-Hertz field frequency. Using this, the HDTV programs that presently exist can be switched over to the new standard. In total, an amount of 1.8 billion Netherlands guilders will be needed for the development of ADTT. Philips together with the Ministry of Foreign Affairs are contributing about 200 million guilders. Discussions have not yet taken place about the exact division of the investment. In the meantime, more than 35 groups have asked if they can participate.

Germany: 'Butler Programs' Help User During Journey on Data Superhighway

94WS0485B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 4 Aug 94 p 8

[Article by David Rosenthal; "The 'Butler Programs' Will Help in the Retrieval of Desired Information. With the Information Highway the Infrastructure Will Be Laid For Future Mass Markets"]

[Text] Bill Clinton and Al Gore in their election contest made popular the dream of an information highway. Any

person at any time should have access to all information. In Europe the subject of a high-capacity information network is nothing new. Already a decade ago there was talk of an information highway. Many observers also say that in Europe we are already much more advanced than is America.

Among us we also may have a vague understanding of the information highway. One thing is for sure, here the infrastructure is being laid for mass markets of the future. Production of equipment, software and high-quality services within a few years may develop from what could be regarded as nothing to billions of marks.

In these years the technology for setting up and further development of a high-capacity information network will undergo enormous advances. The information conveyance capacities which for today's conditions are tremendous will change simultaneously with their use capabilities. The information highways will make affordable forms of communication which for many today may be unaffordable or too strange.

That applies, for example, to the transmission of pictures by telephone. The price of the equipment is essentially a question of production volume. However, it was primarily the conveyance of the videosignal which was too expensive. This necessitates a considerably higher capacity than a telephone conversation. On this point branch specialists predict that in the coming years such ventures will begin first with networks set up within one own's business and later also expand to outside communication lines.

If the prices fall the market will be open to a broader public. It is highly probable that videocommunication via personal computer will be developed. Even today a good many computers are supplied with microphones. In the future minicameras may be added, mounted on the monitor. The picture of the conversing parties will appear in a display window. The two parties will exchange their information at the same time or can work with the same programs.

Prior to a telephone over which the conversing parties can see one another, the introduction of electronic mail (E-mail) will become commonplace, even in one's private life.

Services on the information highway based on the model of today's on-line services such as Compuserve or Datex-J will ensure that an increasingly greater number of persons at home will no longer be reachable only by telephone or mail, but also electronically. The appointment with the barber will be arranged by E-mail, banking business will be attended to at home and the filing of tax returns will be by computer.

Electronic conferences also will make possible contact with unknown parties. An electronic roundtable concerning wine pressing, marine pollution or planning strategies in shrinking markets will then take place in "cyberspace." Thereby virtually the entire world will be brought onto the information highway and this will take place everywhere almost simultaneously because the information travels in the network with the speed of light.

The participants in a discussion can be scattered over the entire globe. The information highways overcome distances. This also holds true for other fields of application and with increasing information carrying capacity the network will be able to become profitable. Instead of their own small school library students one day will have access to the assembled knowledge of mankind.

Via the information highway one will be able to access very distant libraries, whose databanks will be scrutinized and the located electronic books will then be copied onto one's own computer. Even today there are many hundreds of such knowledge databanks throughout the world accessible via public information networks, in many cases even free of charge. The classroom must now be linked to these networks and the teacher must be trained in how to use them. The research capabilities naturally also are made available to private individuals, enterprises and administrations.

Even today the abundance of information available, even in considerably reduced volumes, scarcely can be coped with. Since many persons still have difficulty in retrieving a letter in their personal computer, the software manufacturers wish to put so-called "agents" at their side.

These are personal so-called "butler programs" which constantly are on duty on the information highway and which pick up all that information in which their "masters" might be interested. For example, all the articles concerning goldfish which have been published in the last three months or concerning the momentary most favorable price for a VCR. This agent could likewise procure a certain chapter from a book in the National Library.

Each user will have his own agent. They also could see through such tasks as the booking of a trip. They could independently bargain with the (likewise electronic) travel bureau about the conditions. An agent could procure concert tickets, reserve a tennis court or agree on the time with the agent of another person. The agents know what is desired. As soon as the latest CD of a certain artist appears, they report on this.

Work can be shifted from offices to homes via the information highway. Information highways are therefore a substitute for mobility. With picture, sound and information linkups, telecommunication will make the spatial nearness of many fellow workers superfluous.

It is already possible today, for example, to transfer an incoming telephone call at a company to the private number of the pertinent employee. Within a few years everyone will be reachable by dialing a single telephone number, whether he be in the office, at home or enroute. The information highway by then will be conspicuously capable of performing highly sophisticated functions. In other words, the distinction among individual communication modes will gradually begin to fade. The system on its own will ascertain how a message should be sent in the quickest, safest and most inexpensive manner.

The information highway also will help to improve health care and to lower costs. Even an outlying hospital in this

way can take advantage of the know-how of an experienced specialist at a very distant major clinic after a severely injured patient has been admitted. Patient data, laboratory findings and X-ray pictures can be transmitted within a few seconds.

Experiments already have been carried out using such information channels with the performance of entire operations using remote-controlled scalpels. The military also has an interest in this. For example, specialists could simultaneously serve several field hospitals from some distance.

In the same way there is an economic saving. In the United States and Japan, for example, there are banks which also have been able to dispense with their expensive topnotch advisors in branch offices. In this arrangement the customer sits in the cashier's office with a telephone, over which the two parties can see one another while the business advisor works in his office at the central bank. The bank can make better use of its personnel and operate more efficiently.

Even today, as was mentioned, researchers around the world are collaborating via the Internet network: each university, each research institution which is keeping pace with the times is linked to it. Research results, opinions, numerical data and other information is being exchanged and disseminated via Internet. Internet is frankly a functioning chaos. It "belongs" to no one, is being supported by all and already today is indispensable. Many in the telecommunications branch regard it as a model of a future world-encompassing information highway.

France Telecom Expands Telecommunications Network

More Fiber Optic Cables

94WS0445A Paris MESSAGES in French May/Jun 94 pp 16-20

[Article entitled: "Moving Toward All-Optical"; first paragraph is MESSAGES introduction]

[Text] **National trunk lines and regional networks will all be equipped with fiber optics before the end of the century. As part of a sweeping modernization plan it launched last March, the public carrier will invest 20 to 25 billion French francs [Fr] annually over six years. Later, fiber optic cable will be run right into subscriber homes and offices.**

The network of the 21st century can only be fiber optic. Convinced of this truth, France Telecom unveiled a plan to upgrade its network in late March that highlights fiber optic technology. The program calls for installing 2 million kilometers of optical fiber by the year 2000. "This plan will enable us to continue our policy—consistent since 1985—of lowering our rates overall and enhancing our service," asserted France Telecom general director Charles Rozmaryn when the program was presented.

Lower rates and new services, yes, but also a race to boost performance. In 1998, all the telephone companies in Europe will compete with one another, and technological leads will be decisive. A key element in modernization will be fiber optics. Over the last 10 years the use of fiber optic cables has grown by leaps and bounds, both for undersea intercontinental links and long-distance ground ones, where fiber optics is gradually replacing coaxial cable and Hertzian beams.

Although big international and national trunks are already equipped, the introduction of fiber optics into the national network is a longer-term affair. The plan to equip the transmission network was launched at the end of the 1980s, and is now about halfway complete: 12,000 kilometers of fiber optic cable have been laid for the national network. The second phase that began this year will boost that figure to 17,000 kilometers by mid-1995. The national network will be virtually complete in late 1996, when 21,000 kilometers of optical cable will have been installed. Equipment of regional networks will continue at that time: technicians have so far laid 22,000 km of cable, and will install 80,000 by the year 2000. Investments will total Fr20 to 25 billion a year over six years.

The use of coaxial cable will be totally discontinued in 1997, and Hertzian beams will have virtually disappeared by 1998, except in areas where cable is impracticable. As ambitious as it is, the modernization plan affects only large infrastructures—the long-distance, national, and regional networks—and not the distribution network, which runs right to the subscriber. Will France Telecom equip with fiber optic cable the multitude of secondary roads—or local railroads, to stick to our transportation metaphor—that make up the distribution network? "The government asked Gerard Thery to mull over this question," notes Charles Rozmaryn. "One of his assignments is to study the best ways to transmit images, voice, and data directly to the subscriber."

Although France Telecom does not want to prejudge Thery's findings or the major choices that will result, it has not ruled out the possibility of introducing fiber optics into local networks. As early as 1990, it commissioned CNET (National Telecommunications Study Center) to research the question under the project name Radome. The Radome study explored the various technical-economic constraints associated with three major scenarios: Fiber to the Curb (FTTC), Fiber to the Building (FTTB), and Fiber to the Home (FTTH).

Offering Fiber Optic Cable to the Average Consumer

The first two solutions are the least costly, for they allow France Telecom to serve subscriber groups and thus reduce costs. Since the fiber optic cable stops either at the building or the curb, customers connect to shared equipment via classical links. Big companies in greater Paris are already familiar with this kind of service, through the "flexible optical connection" (FOC) plan. Implemented at 32 sites, FOC is now available in over 200 buildings in Ile-de-France business districts, and is ultimately expected to link 1,500 buildings throughout the country. As extensive as it is, the FOC plan is nothing compared to the decision to run optical cable into the homes of average consumers.

This possibility of all-fiber optics is something big European operators are already preparing for. Germany's Deutsche

Telekom, which installed 300,000 optical connections in new Lander local distribution frames in 1993, plans 500,000 connections in 1994 and another 500,000 in 1995. After a series of experiments completed in early 1993 and rounded out this year by residential tests, the British are considering a large-scale installation around 1995-96. The Dutch plan to create an integrated-cable telecommunications and television system by connecting individuals via fiber optics in 1997.

France Telecom has also shown an interest in fiber optics for individual subscribers through the RDFO (Fiber Optic Distribution Network) project it launched in 1992. The project aims to test high-data-speed networks running directly to the subscriber on a realistic scale in four French towns. The experiment will cost Fr30 million per site. According to Henri Paciullo, who is in charge of the project at CNET-Lannion, "the four tests will first and foremost demonstrate our know-how in the installation of optical connections." "Our goal," he continues, "is not to test new services, but to devise methods to install, operate, and maintain fiber-optic local networks."

The four sites are distinctly different, both in terms of habitat and technical solutions—not to mention the companies selected by France Telecom. Epagny, in the suburb of Annecy (an urban area dominated by small tradespeople), was assigned to the manufacturer Secre, which developed a CNET-specified distribution system for passive optical networks. SAT is responsible for Arachon, a residential urban site, and will use equipment made by Siemens, the French manufacturer's usual telecommunications partner. The detached-housing area of Seris, in greater Paris, will be equipped by Raynet, a subsidiary of the American group Raychem. Since Raynet's technique is designed to support teledistribution services, the town will also get a fiber-optic cable television network.

So will the final site, Bastia. In Bastia's case, however, the fiber will not run up to the building or curb, as in the three previous experiments, but all the way into the individual's home. France Telecom chose the French group Alcatel to carry out this project. Unlike the three other tests, which should begin before the end of the year, the first demonstrations in Bastia will not take place until 1996. Alcatel laboratories are still working on the necessary equipment, in particular the opto-electronic connection boxes installed in subscriber homes.

What services will these networks offer? "Just the usual," replies Henri Paciullo. Consequently, the 300 subscribers connected per site will see no visible sign of the switch. They will continue to enjoy the same services as before, namely, telephone and related services for residential customers, and primary Numeris links and specialized analog and digital connections for businesses and companies.

When, then, will all French homes be connected by fiber optics? "Certainly not until the next century," predicts Henri Paciullo. "It is not so much the price that is a problem: the cost of optical fiber has dropped from Fr3 to 50 cents a meter over the last three years. It is more the very high cost of terminal components." All-fiber-optics is still a costly technology. But the advent of multimedia—for which France Telecom has just created a specialized subsidiary—will undoubtedly accelerate the process.

Table Information: France Telecom's Current Networks

France Telecom's switched telephone network carries both voice and data at speeds of 1,200 to 19,200 bits/sec over 31 million lines. Its Numeris network offers voice, data, and still or semi-animated images through three types of accesses. The 121,000 existing basic accesses transmit at the rates of 2 X 64 kbits/sec and 16 kbits/sec. Its 14,000 primary accesses send information at 30 X 64 kbits/sec and 64 kbits/sec. Transpac links transmit at 16 kbits/sec. The public carrier's Transpac network carries all kinds of digital data at 300 bits/sec to 1.9 Mbits/sec. Traffic totals 450,000 million bytes a month. Finally, the Transfix network carries point-to-point digital data (specialized links) at 64 kbits/sec to 2 Mbits/sec. It can also supply customized lines at 34 Mbits/sec. Transfix boasts 100,000 subscriber connections.

Boxed Material: From Trees to Petals

France Telecom is totally rethinking the overall structure of its transmission network. The carrier's plan to switch from the present tree-like structure to "optical loops" aims to guarantee double access to the network at all levels, to protect fully against failure or sabotage.

The new-generation network will include two types of optical loops: large "petals" to interconnect major urban areas, and regional loops adjacent to the petals. In case of failure on a trunk line or piece of network equipment, traffic will automatically route to the second branch in the loop. France Telecom plans an additional level of protection, involving reserve links. The first systems are being set up in the national network. The first petal transmitting at 2.5 Gbit/sec per fiber (30,000 lines) will be complete in the fall of 1994, and will serve big cities in the north of France. The whole system of optical loops is expected to be up and running by the end of the decade.

Research into Intelligent Networks

94WS0445B Paris MESSAGES in French May/Jun 94 pp 20-21

[Article entitled: "Networks Get Smart"; first paragraph is MESSAGES introduction]

[Text] Networks are not just main and secondary roads. They are also techniques—notably electronic switching—which pave the way for new, subscriber-controlled services such as call screening and universal numbers. CNET laboratories are working to design the future "smart network", which will be able to adapt, even to services that have not yet been invented.

Networks continue to amaze us. The introduction of fiber optics, digital high data speeds, widely-used packet techniques, and multiservice functions has created the "smart network." Smart networks are meant to facilitate the development of "network services" using basic services (packet and word transport) as a starting point. For the subscriber,

this means access to a whole array of new functions, including call screening, callback, toll-free calling, and more.

But how have networks gotten smart? "The advent of electronic switching, and particularly the widespread use of recorded program switching systems, marked the first step toward a pre-intelligent network," explains Roberto Kung, head of the network structures and services department at CNET's Paris-A center. These technical breakthroughs paved the way for toll-free numbers in 1983, followed by the Pastel Card, which later become the France Telecom card, in 1989.

The introduction of these new features quickly ran into a technical wall. "The system is so complex that it takes five to six years to introduce a new service," admits Robert Kung. "Each program, each system, and each type of switchboard must be altered."

The solution is to build a network architecture that centralizes all programs and databases, and controls all switchboards without the need for equipment intervention. Costs and implementation times shrink accordingly. Such an architecture is already operational on the Itineris network. The new version, which was installed this year, will make it possible to cut to 24, then 12, and finally 6 months the time it takes to introduce or modify a new service. And its use should gradually spread to all networks, whether mobile, packet, wide-band, or other.

CNET is heavily involved in studies of intelligent networks. France Telecom's research center is currently studying infrastructures, and is looking at the introduction of new functions in network nodes, the installation of smart peripherals and control points where services are processed, and the creation of the first recording centers tailored for smart networks. CNET writes the specifications, monitors manufacturing, checks the equipment, and does the network integration for all these developments.

Longer-term studies were combined in the three-stage CNET-Serenite (Smart Digital Telecommunications Network Service) project. The first stage looked at changes in architecture, particularly the connection between various applications (network, management, computer). The second involved typological and service-interaction studies, with a view to understanding needs better and making sure system architecture meets them. The final phase was devoted to programming-interface studies and the development of tools to facilitate the creation of new services.

Toward an All-Mobile Telephone Service

So what will these future "network services" be? In no particular order: universal numbers, which make it possible to reach scattered lines through the same number based on geographical or commercial criteria; personal numbers, which will allow everyone to be reached at one number, after signaling his/her location; and all-mobile telephone service, which will extend cellular phone service to every kind of terminal. Another possibility is "televoting," notably for public opinion polls; the network will count calls without answering them, as it does today.

As you can see, smart networks offer substantial advantages. "Not only do they make it possible to introduce new services, but they can also adapt to changes that are tough to predict today," adds Roberto Kung. In other words, they are both intelligent and flexible. Furthermore, unified architecture enables carriers to implement a uniform management and operation system, and to integrate and interconnect services on different types of networks. In short, smart networks are an essential step on the road to the information highways of tomorrow.

Italian Firms Win Telecom Contracts in Malaysia, Russia

MI1108090194 Milan IL SOLE-24 ORE in Italian 28 Jul 94 p 12

[Text] Public and private Italian industries have won two important contracts from abroad. They have been awarded to Pirelli and Italtel (of the IRI-STET [Institute for the Reconstruction of Industry - Turin Telephone Finance Company] group). The new Malaysian optical telecommunications network will in fact be supplied by Pirelli Cavi, whereas Italtel has designed, constructed and installed the first operative GSM [Global System for Mobile Communications] cellular telephone system in Russia.

The contract was sealed yesterday in Kuala Lumpur, the capital of Malaysia, by Italian managers and representatives of Time-Telekom Malaysia, that is one of the biggest private carriers in the sector, and it is worth over 90 billion lire. It concerns one of the most important optical highways to be constructed by a single supplier in southeast Asia, and will permit integrated transmission of data, video, and sound, thanks to the system's particularly advanced technical characteristics and transmission capacity.

The project will provide Malaysia with one of the most important infrastructures for the country, and it is part of the national development plan called "Vision 2000." This infrastructure will help the rapid economic development that is taking place in Malaysia, which has had the fastest growth of gross national product in the world for four years. Under this agreement, Pirelli will supply and install a turnkey submarine optical cable system, 1,600 kilometers long, which will run round the entire perimeter of the country.

The Milan-based company will also make use of the experience it gained from the construction of the optical fiber network that runs down the entire length of the Italian

peninsula, built for Iritel between 1989 and 1991, and having a total length of 2,200 km. This was the first network of its type to be constructed in the world.

Finally Italtel has taken portable telephones to Russia. The first GSM in the country was installed in the city of Kogalim, located in the transural province of Hanti Mansijsk in the large Siberian region of Tumien. According to a note, the system is composed of an exchange of UT [Universal Telecommunications] lines dedicated to radio mobile communications, and two radio base stations. A further amplification of the same network, already programmed for the beginning of 1995, plans for another eight radio base stations to come into service. The total value of the order is 16 million dollars (over 25 billion lire). Delivery was preceded by tests of its functionality and operation to verify that the Italtel system completely corresponded to the requirements of the client, the local telephone administrator.

AEROSPACE

Czech Aviation Industry Restructures

94WS0428A Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 30 May-5 Jun 94 p 10

[Text] Aero Holding, the consortium that controls the entire Czech aerospace industry, is making itself over. A recent restructuring plan calls for the holding to retain only four of its current nine members. The select include Aero Vodochody, Letov, Technometre, and the VZLU Aviation Institute, all of which are active in the L-39, L-59, and L-139 trainer aircraft programs. The state "National Property Fund" will maintain a majority stake (53 percent), while 30 percent of the consortium's shares will transfer to the Konsoldaci Bank. Let, which builds the L-410, 420 and L-610, "Zlin" light aircraft manufacturer Morovan, and the enginemaker Motorlet will all be sold. The American firm Fairchild already holds stock in Let through a joint venture created in 1992, while Pratt & Whitney Canada is discussing a possible takeover of Motorlet. If no one steps forward to buy Morovan, the company will be sold to the Investicni Postovni bank. One of Aero Holdings first companies, Teset (landing brakes), has already been acquired by Bohemia Bank. Two firms, Mesit (avionics) and Cenkovske Strojirny, will be liquidated.

New Polish Trainer Makes First Test Flight

94WS0428B Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 30 May-5 Jun 94 p 10

[Text] Eight months after the launch of the Polish firm PZL's M-93 program, the aircraft made its maiden flight last 24 May. The airplane, which is christened Ivan II, is a new version of the Iryda I-22 trainer, converted for ground attack by adding more powerful engines and efficient avionics. Sagem, the program's venture-capital partner, supplied the M-93's navigational and attack system (based on a Uliss inertial unit) and integrated the cockpit's headup and headdown displays.

TELECOMMUNICATIONS

Poland: Telecommunications Development Plan Up to 2000

94P21082A Warsaw PRZEGLAD RZADOWY in Polish No 5, May 94 pp 89-92

[Statement by Minister of Communications Andrzej Zielinski on implementation of the program "Strategic Plan for Telecommunications Development to the Year 2000"]

[Text] Last October, the government adopted a program for the development of Polish telecommunications. The January issue of PRZEGLAD RZADOWY published the report on its implementation. In the near future, the Council of Ministers will be briefed by Minister Andrzej Zielinski on progress in the implementation of the tasks.

Expansion of the International Network by Increasing the Number of Connections and Bundle Capacity

The entire volume of international telecommunications traffic runs through three digital exchanges in Warsaw, Katowice, and Poznan. Automatic international traffic is sent to 108 countries throughout the world. Digital as well as analog transmission systems are used. The ultimate goal is to use digital systems exclusively because they make non-telephone services possible as well.

To open new connections and to incrase the capacity of existing international cables, the following are being used:

—Satellite systems under development: INTELSAT, EUTELSAT, INTERSPUTNIK.

—Fiber-optic systems in connections with neighboring countries:

—The coastal line from Koszalin to Copenhagen (already in service).

—Surface lines: from Cieszyn to Prague (already in service), from Zgorzelec to Frankfurt am Main (already in service), from Suwalki to Kowno (already in service), from Warsaw to Minsk (construction scheduled for 1995), from Poznan to Berlin (already in progress), and from Krakow to Lvov (already in progress).

Because there is no direct digital connection with Russia, talks are being held on extending the fiber-optic line from Minsk to Moscow and on the possibility of constructing a fiber-optic line to Kaliningrad.

It is expected that, in 1995, there will be a total of 9,410 two-way links, including 5,547 in Warsaw, 1,620 in Poznan, and 1,920 in Katowice. In the year 2000, 18,230 links are anticipated, including 9,410 in Warsaw, 4,020 in Poznan, and 4,800 in Katowice.

The separate, business-oriented KOMERTEL, which offers a significantly wider range of telecommunications services than the public network (ISDN services), already has 2,500 subscribers and may expand.

Within the INMARSAT satellite system, the construction of a new station to permit mobile telephone or telex satellite communication, the so-called INMARSAT M or C, has been planned. This network will make it possible to provide telecommunications services for domestic and foreign surface transport as well as maritime and coastal transport throughout the world.

Completion of the New Long-Distance Automatic Exchange Network

As far as switching is concerned, this program covers 49 long-distance exchanges, including 12 transit long-distance exchanges. The completion of the construction of these exchanges is scheduled for 1996. To date, 38 exchanges have been constructed, with 208,590 links. The other 12 exchanges will have 36,960 links. These exchanges will be connected by a network of digital links, and, to facilitate their interaction, signaling system No. 7 (ISUP) will be employed.

At present, analog systems predominate in the long-distance network. In the future, the Ministry of Communications will strive to use a mostly digital network in transmitting.

The first digital systems that were built in the trunk network were the submarine fiber-optic cable from Koszalin to Bornholm (Denmark), implemented in a 140 Mb/sec system, and the Koszlin-Warsaw digital radio link, in a 140Mb/s system, as well as several fiber-optic local lines on the regional level in the eastern and southwestern provinces.

Construction has begun on the following:

—The Koszalin-Gdansk-Bydgoszcz-Warszawa-Krakow-Katowi ce-Cieszyn fiber-optic line, which is equipped with 140 Mb/s hardware manufactured by NKT (Denmark), approximately 1,500 kilometers long.

—The Zgorzelec-Wroclaw-Sieradz-Lodz-Warsaw-Olsztyn fiber-optic line, with a branch to Sieradz-Poznan-Bydgoszcz, equipped with 140 mb/sec hardware manufactured by AT&T (USA and the Netherlands), approximately 1,300 kilometers long.

—Sixteen 140 Mb/s digital radio links manufactured by NEC (Japan), over 3,000 kilometers long.

At the turn of 1993/94, most of the lines went into operation. These lines provide digital connections for over 30 operational long-distance exchanges and, at the same time, make it possible to hook up the digital connections of the three international exchanges in Warsaw, Poznan, and Katowice with European and worldwide long-distance networks.

Modernization of Major Telecommunications Centers

The telecommunications centers in Warsaw, Gdansk, Krakow, Szczecin, and other large Polish cities will continue to expand.

This year, telecommunications centers, with a total volume of 739 000 NN [Neural Network], will be incorporated into the network, including:

—Warsaw center—150,000 NN
—Krakow center—183,000 NN
—Katowice center—173,000 NN
—Poznan center—87,000 NN

Development of the Mobile-Landline Radio Communication Network

Currently, the cellular network of the NMT 450-CENTERTEL system serves 16,000 subscribers in Warsaw, Krakow, Lodz, Szczecin, and Wroclaw, as well as in the greater Gdansk and Katowice areas.

As of January 1994, about 80 base stations (with 113 cells each) were in operation, with the possibility of hooking up 30,000 additional subscribers. Approximately 30 percent of Poland's territory, with almost 50 percent of the population, is served by this network. By the end of 1994, the network will encompass 60,000 mobile stations, which will allow 70-75 percent of the population access to the network. According to research by Polish Cellular Telephone, at the turn of 1994/95, it will be possible to reach this network's technical break-even point. This situation can be avoided by introduction of the Pan-European GMS 900 system, but, at this time, this frequency is occupied by another user.

—***The CT2 and DECT wireless telephone systems.*** The CT2 has not attracted a great deal of attention in the world (France, East Asia). The DECT system is more technically advanced than the CT2. Introduction of this system can be expected by 1996, provided a frequency allocation is available.

—***The DSRR dispatch system.*** The dispatch system of RadioNet is not developing dynamically (there are a relatively small number of subscribers), and, therefore, no work is being done on new versions of it.

—***The ERMES paging system.*** Demand for ERMES services depends to some extent on expansion of the GMS cellular telephone and must be preceded by market research. Fast implemmentation of the ERMES system is possible using the locations and infrastructure of the 160 MHz mobile bases.

Expansion of Mobile Maritime and Aviation Radiocommunication

In the INMARSAT satellite system, the construction of a new station that would enable mobile telephone and telex satellite communication (so-called INMARSAT or C) has been planned. This station will offer its customers telecommunications services for domestic and foreign ground and maritime transport all over the world.

Introduction of the GMDSS maritime rescue system. As a part of this system, a medium-wave link has been installed in the middle of the coastline at the station "Witowo Radio" in Jaroslawiec, serving Polish zone A-2 (covering the Baltic and neighboring regions). The link is equipped with hardware for DSC digital selective calling on international frequency f = 2187.5 kHz. This link is connected to the Polish Maritime Rescue Service in Gdynia via a leased exchange line. An additional standby link for zone A-2 is being considered at "Gdynia-Radio."

The VHF GMDSS system has obliged Poland to set up an A-I zone by 1995, which means that a zone of 20-30 nautical miles along the coast will be covered by VHF channel 70 for DSC calling in emergency situations and channel 16 for safety communication. Under these circumstances, the VHF network along the Polish coastline will be given new branches in Leba nad Krynica Morska.

Introduction of a communications system for airline passengers (TFTS). On Polish territory two ground stations have been planned, one near Gdansk and other near Lodz. Neither LOT [Polish National Airlines] nor the ZRL [Air Traffic Board] has so far expressed any interest in this proposal.

Nontelephone Networks

Paging services. The only all-Poland paging network is POLPAGER (operator TP SA). This network serves approximately 30 percent of all paging services. Currently, POLPAGER has 8,000 subscribers, and the number is increasing steadily. Other competing agencies are TELEPAGE, BELLPAGETTE, and others.

POLPAGER uses USW transmitters belonging to TP SA as well as private transmitters. Digital recivers that can receive only digits, or alphanumeric receivers that receive up to 64 text characters are used.

Data transmission in an X.25 packet network. The POLPAK data transmission network includes 18 nodes located in major cities and has about 1,320 ports, 700 of which are already in use. The network allows operation according to protocols X.25, X.28, X.32, based on the 1984 CCITT requirements. The speed between nodes is 9.6 Kb/s, which means that the POLPAK network is less useful connecting remote LANs and, in its present version, serves mainly to connect individual terminals. The network is directely connected to packet networks in France, Germany, Great Britain, and the United States, and, through them, to about 70 X.25 networks around the world. Modernization of the POLPAK network in 1994 includes:

—Switching to digital links in international traffic between centers.

—Giving customers access to digital links and increasing the speed on them to 64 Kb/sec.

—More nodes (Bydgoszcz, Kielce) and the installation of so-called concentators in order to increase network range and the number of ports.

In addition, the purchase of a new software network that would allow separation of virtual networks meeting CCITT X.25 requirments (1988) is under consideration.

The MHS news service system. Some elements of the MHS service system support the POLKOM system in Warsaw. It is mainly intended for international retransmission of telegrams and also offers electronic mail, "store and forward" service for faxes, and information mode conversion—for example, telex to fax. POLKOM is not connected to the packet network and is therefore outmoded. The purchase of a modern MHS system is planned, (with electronic mail) operating under the X.400 standard with the X.500 electronic teleaddress book and an electronic document interchange (EDI) module. The installation of one to three modules connected to the POLPAK network has been planned initially, with a capacity of 2,000-2,500 boxes. The technical requirments have been met. Provided there are the financial means for it, this system could be in place within a year.

Audiotext services. In 1994, modern audio information services and talk shows are to be introduced on a trial basis and, in the future, audio mail, televoting, etc.

ISDN services. In 1994, a pilot ISDN system (a module with a capacity of 512 subscribers) will be installled in a 5ESS exchange in the KOMERTEL network. Prepartions have been made for a pilot ISDN network in Warsaw that will utilize other exchanges of types ESWD and 1000 S12.

Construction of a high-speed skeleton data transmission network. This modern transmission network will facilitate the "Frame Relay." The international transit nodes would be located in one to three cities, and the other nodes would be located in 10 large Polish towns. The internode speed will be a minimum of 2Mb/s, with fiber-optic cables and digital radio lines. If funds are provided, the network can be finished within a year.

Activation of the VSAT satellite network. The VSAT network was ready for operation at the end of 1993. It uses AT&T equipment and has central stations (a hub) and 80 VSAT satellite terminals. This network makes it possible to transmit data according to X.25 at a speed of 64Kb/s between terminals, as well as to and from subscribers to the POLPAK network. Plans call to use the VSAT network in telephony in the future.

The current central station equipment makes it possible to control a network of about 2,000 VSAT terminals.

The central station VSAT operates a network of more than 100 VSAT terminals in Hungary under the terms of an agreement between TP SA and the Hungarian MONTANA organization.

Regulatory Policy

The work on amending the law on communications is nearing completion. The document is being studied by various ministries.

The procedures for issuing licenses for telecommunications activities and official certification have been determined. The formation of the regulatory agency for these activities is under way, and consultants paid from the PHARE [Economic Reconstruction Aid for Poland and Hungary] fund are participating in it.

Policy to Finance Telecommunications Development

By the end of 1993, 73.6 percent of the credits from the World Bank, in the amount of $120 million, and ECU70 million from the European Investment Bank had been used.

These credits financed the following:

—MITUI-NEC (radio lines), contract value $22 million, 95 percent used.

—AT&T Network Systems Nederland B.V. (fiber-optic cables), contract value $30 million, 75.3 percent utilized.

—Satellite Transmission Systems (EUTELSAT), contract value $5 million, 76.5 percent utilized.

—Siemens AG (international exchanges), contract value ECU44.7 million, 68.6 percent utilized.

A Korean Government loan of $50 million for supplying telephones to the Opole voivodship, 89 percent utilized at the end of 1993.

A loan from the Spanish Government in the amount of $58.9 [as published], devoted to contracts with ALCATEL SESA/SETEL, to be utilized for subscriber exchanges, transit exchanges, and relays, 100 percent utilized.

The second-quarter credit agreement for this year between TP SA and the European Bank for Reconstruction and Development on a $100 milion credit for expansion and modernization of the Warsaw Telecommunications Center.

The World Bank and the European Investment Bank have indicated a willingness to issue a follow-on credit for TP SA for construction and modernization of local networks in the amount of $600 million, to be utilized in 1994-97. To obtain this credit, State Treasury guarantees are needed.

In 1994, implementation of the plan titled "Expansion and Modernization of the Telecommunications Network in Gdansk Voivodship" (the so-called Gdansk Proposal). This plan will be financed by credits from the European Bank for Reconstruction and Development, a consortium of private banks led by ABN-Amro from the Netherlands and a credit acceptance firm—namely, AT&T—totaling $127 million. These credits will be paid off from future revenue derived from new subscribers.

In the State draft budget for 1994, 95 billion zlotys have been allocated to provide telephone service to rural areas.

Fee Policy

The rules on telecommunications fees were changed recently. The European model was adopted. Schedule fees have been "leveled."

Technical Policy

An executive order from the Minister of Communication dated 16 July 1993 describes the technical and operating requirements and conditions for interoperability of telecommunications devices, cables, and networks being used on the territory of the Polish Republic.

Personnel Policy

Because the development of a telecommunications network requires highly skilled personnel, training sponsored by PHARE 92 is being given in the Ministry.

AEROSPACE

Brazil: First Embraer EMB-145 To Be Assembled in February 1995

94WS0438A Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 13-19 Jun 94 p 15

[Article by Bernard Bombeau: "First EMB-145 Will Be Assembled in February"]

[Text] The four principal venture partners cooperating on the future twin-jet regional EMB-145 have entered the production phase. In Chile, the Enaer [National Aeronautical Enterprise] is working on assembly of the center section of the vertical tail plane, which will be accepted in Brazil next August. The Belgian firm Sonaca [National Aerospace Construction Company] is scheduled to deliver the fuselage tail section and the center section in October or November of this year. The Spanish Gamesa Aeronautics group expects to deliver the first two wing center sections to Embraer [Brazilian Aeronautics Company] in January. C&D Interiors, a U.S. firm, presented the final interior layout of the aircraft in Sao Jose dos Campos at the end of March. Lastly, certification of the Allison AE3007A jet engines (3,190 kg per unit) is expected this summer.

Embraer has begun manufacturing the parts and subassemblies and, in cooperation with Liebher Aero, the German equipment manufacturer, has finished machining the main landing gear. The development timetable for the future EMB-145 calls for assembling the first aircraft in February 1995 for an inaugural flight in April. Plans call for a development prototype and three pre-production aircraft for FAR-25/36 certification in the early summer of 1996. Officially, the promoters of the Brazilian aircraft are now down to only about 100 letters of intention—from 14 airlines—that may be converted into options by the end of the year. The only firm customer, announced in Singapore at the start of the year, is Australia's Flight West Airlines. It has actually issued only two firm orders for aircraft and two options. Embraer is saying nothing about the purchase, reported in April to be imminent, of five aircraft by a "big European airline."

India To Develop Engine for Civil Transport

94WS0438B Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 27 Jun-3 Jul 94 p 21

[Article by Vivek Ranghuvanshi and Jean-Pierre Casamayou: "India Designing CFM-56 Class Engine"; introductory paragraph in boldface as published]

[Text] **This engine will be based on the LCA fighter plane's Kaveri jet engine, which is about to run for the first time.**

The GTRE (Gas Turbine Research Establishment), an Indian aircraft engine research center, has just announced that it intends to develop a civilian engine in the CFM-56 class. This new turbofan engine is reportedly derived from the military Kaveri engine designed for the national LCA fighter plane. The first unit ready for ground tests should run for the first time in September.

It was in the 1970's that the GTRE launched a program for a military engine christened the GTX. A first single-flow demonstrator, but with afterburner, ran on a test bench as early as 1977. That engine, with a rating of 44 kN dry and 64 kN with afterburner, was followed by a more powerful bypass version (ratio of 0.2) with 90 kN of thrust. Based on that experience, Indian engineers launched the Kaveri program in 1981. The goal was to develop an engine called the GTX-35VS for the national LCA fighter plane. The "hot section" consists of a high-pressure six-stage compressor (compared to seven in the demonstrator), an annular combustion chamber, and a single-stage turbine with cooled blades. The low-pressure section consists of a three-stage compressor driven by a single-stage turbine. Total pressure is 21.35, while the bypass ratio is very low: 0.16. This indicates that the engine is designed for high-altitude interception missions. The prototype will have a variable-section nozzle with electrohydraulically operated vanes. The production models, on the other hand, are to have a convergent-divergent nozzle. It should be noted that the Kaveri engine will be equipped with a full authority digital engine control (FADEC) system. Officials at the GTRE also state that the Kaveri will have a rating of 50.7 kN dry and 80 kN with afterburner. Its thrust-to-weight ratio will be 7.8. They also estimate that certification will be obtained around the year 2000 with a view to starting production in 2005. Since the engine will not be ready as soon as the aircraft, the LCA prototypes will use General Electric F404 engines at first.

Meanwhile, tests on the hot section have demonstrated a power level of 5.5 MW at 16,000 rpm. According to Indian engineers, that is enough to develop a thrust of 110 kN. Hence the idea of designing a civilian derivative, just as the CFM-56 was based on the core of the military F101 engine. The first diagrams show an engine whose hot section is the same as that on the GTX-35VS, with a fan unit produced by simple homothetic transformation of the first stage of its low-pressure compressor.

BRAZIL SPACE, NUCLEAR, S&T NOTES

94P21019A

[Editorial Report] SINO-BRAZILIAN SATELLITE PROJECT FUNDED—The National Space Research Institute (INPE) will receive $6.5 million for the China-Brazil Earth Resources Satellite (CBERS) program beginning the week of 20 June, the Sao Paulo daily GAZETA MERCANTIL reported in its 16 June issue. Another $2.5 million will be allocated to completing the construction of the Weather Forecast and Research Center (CPTEC) building in Cachoeira Paulista, Sao Paulo. According to INPE Director General Marcio Nogueira Barbosa, the allocation will come from the government's privatization program, and the Bank of Brazil (BB) will advance the funds to the Ministry of Science and Technology (MST). The funds are to be released as part of an agreement signed in November 1993 between the MST, BB, and the Funding Authority for Studies and Projects (FINEP). The agreement guaranteed the release of $21 million for the CBERS and CPTEC projects and the Brazilian Complete Space Mission (MECB) satellites. By the end of 1994, INPE intends to negotiate the release of an additional $10 million for its satellites projects.

GAZETA went on to quote Barbosa as saying that the $6.5 million that INPE will receive for the Chinese-Brazilian satellite program will be used to bring new industries under contract for the CBERS project and maintain existing contracts. Barbosa added that seven supplier firms of electronic and mechanical equipment for the satellites are involved in the project: Automation and Control Systems Engineering (ESCA), Aeroelectronics, Brazilian Electronics (Elebra), Digicon, Mectron, Brazilian Aeronautics Company (Embraer), and Tecnasa.

The CBERS program involves the manufacture and launch of two high resolution remote sensing satellites to perform services such as surveying fires and deforestation, and meteorological forecasting, GAZETA continued. The total cost of the project is budgeted at $150 million, 30 percent of which will be paid by the Brazilian Government and 70 percent by the Chinese. According to the agreement signed with China, the integration and testing of the second satellite in the series will be done in Brazil at the INPE Integration and Testing Laboratory in Sao Jose dos Campos. It has also been agreed that Brazil will have operational control over the satellite consistent with its share of participation in the program.

Barbosa further remarked that within 60 days, Brazil will present a proposal to China for marketing the data and images from the CBERS satellites. He said that the idea is to create a binational firm to exploit that information, and that the user market for those satellites worldwide is estimated at $6 billion. He added: "Brazil and China should get at least $1 billion."

AERONAUTICS MINISTRY TO OPEN ALCANTARA LAUNCH SITE TO BIDS—The Aeronautics Ministry will hold an international bid sometime during the remainder of 1994 to decide what domestic and foreign firms qualify to use the Alcantara Space Center (CLA). The CLA, reported the 17 June Rio de Janeiro daily O GLOBO, is considered the best site in the world from which to launch satellites into geostationary orbit due to its location two degrees from the equator. Major General Jose Marconi, deputy director of the Research and Development Department of the Aeronautics Ministry, indicated that the government plans to take advantage of CLA's site location to obtain funds to develop it. The base is located on a 62,000-hectares site in Alcantara, Maranhao State, and has only a 2,600-meter runway.

With a $9.52 million budget for 1994, a tenth of the sum requested, the CLA will depend on funds from foreign firms associated with domestic firms to construct a runway capable of accommodating "vehicles of the spacebus type" and areas for large foreign or domestic launchers. Russian and American firms have already presented proposals that are being studied by the Aeronautics Ministry.

FIRM TO DO VIABILITY STUDY ON CUBAN NUCLEAR PLANT COMPLETION—On 25 May, Inepar Systems, a branch of the Inepar Industry and Constructions "holding" company in Curitiba, signed a protocol with the Governments of Cuba and Russia and the Italian public company Ansaldo, to do a viability study on completing Cuba's Juragua nuclear plant, GAZETA MERCANTIL reported on 20 June. Construction began on the plant located in Cienfuegos province in October 1983, and was suspended in 1992. Rodolfo Andriani, director general of Inepar Trading, Inc., opined that the plant must be reevaluated and adapted to new conditions, adding that construction methods and equipment must be "westernized" to complete it. He said that 75 percent of the plant's construction is completed.

The contract for the viability study was being prepared in Moscow and was expected to be signed in the beginning of July in Genoa, Italy. The study must be completed in six months; however, Ivan Sabatella, head of Inepar's Directorate of Business Development, was absolutely certain of the plant's viability. The Cuban Government's contacts with Inepar, according to Sabatella, began some years ago, and intensified in January 1994 after Inepar's potential opportunities in Cuba were examined. Sabatella remarked: "We are aware of the need to restore that country's economic activities. For them, nuclear energy is fundamental." He anticipated that the Brazilian Foreign Affairs Ministry would not impede the transactions. "From Inepar's point of view," Sabatella said, "it is a private undertaking. Furthermore, the embargo against Cuba comes from the United States and not the United Nations."

According to Inepar Trading Director Andriani, the viability study seeks to make the plant technically acceptable to international organizations and attractive to investors. "It is a way of making it transparent to the western world," he said, and added that "the plant can be immediately subject to international verification and certification legislation regarding the generation of nuclear energy for peaceful purposes."

The Juragua project, according to the Inepar directors, provides for a containment vessel for the reactor and other Western equipment. Andriani said: "Up until now, the technology, in both construction and equipment, has been Russian. The idea, in this new stage, is to conduct open bids and use what is best in the world, independent of the country of origin."

NEW COMMANDER FOR ARAMAR MAY BE NAMED—The Aramar Experimental Center (CEA), a Navy Ministry organization that develops the Brazilian nuclear program, may have a new commander as of August, the Sao Paulo daily O ESTADO DE SAO PAULO reported on 6 July. Admiral Othon Luis Pinheiro da Silva, one of the mentors of the nuclear program and president of the Coordinating Center for Special Projects (Copesp), may move to a compulsory reserve status upon completing his eighth year of Admiralty on 31 July. Immediately thereafter, it is probable that an active duty Navy officer will be selected for the position, O ESTADO speculated.

PLANNING MINISTER URGES CONTINUED ANGRA II CONSTRUCTION—In remarks made in Sao Paulo on 8 July, Mines and Energy Minister Alexis Stepanenko defended the conclusion of the construction of the Angra II nuclear power plant, a project which has been sharply criticized, particularly by environmental groups. The 11 July GAZETA MERCANTIL reported Stepanenko's argument that "Angra II's construction was approved by the National Congress" and that "the $4.5 billion already invested in its construction cannot be ignored." He added that half of the $1.5 billion necessary to conclude the project will come from German financing at favorable interest rates. The minister disputed the preliminary audit by the National Accounting Office (TCU), which indicated that nearly $2.5 billion will be needed to complete the plant, pointing out that there was a discrepancy in the numbers provided by the government regarding investments.

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